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Serial Solutions for Dos

2.8 EDITION August 1995

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FULL 36 MONTHS GUARANTEE.

BRAIN BOXES guarantee your Serial Solutions software for a full 36 months from purchase, parts and labour, provided it has been used in the specified manner. In the unlikely event of failure return your interface to BRAIN BOXES or to your Dealer, with proof of purchase, who will determine whether to repair or replace this product with an equivalent unit.

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ACKNOWLEDGEMENTS.

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Thank You For Buying
Serial Solutions
Software For DOS!

We proudly present the Serial Solutions Software System.

Windows Serial Solution Software.

Serial Solutions is a device driver for managing multiple Serial Ports from DOS. If you wish to control multiple Serial Ports from the popular Windows graphical environment then you need to use the separate Serial Solutions for Windows package.

Introducing Serial Solution Software.

The perfect partner for any Serial Port is Serial Solution Software! Serial Solution is a fully featured suite of programs designed to squeeze the most from PC serial communications.

Serial Solutions software requires the following hardware:-

a) An industry compatible computer running DOS.

b) Any PC standard serial ports, either on main system board or on expansion cards, based on the 8250, 16450 or 16550 uarts. Up to 32 ports are directly supported. Of course, we recommend our own AT Dual, Quad and Lynx 8 port cards which are Made in Britain and have a 36 month guarantee.

Serial Solutions support any mix of RS232, RS422 and RS485 serial cards in the PC.
Serial Solutions support interrupt sharing boards including our own Quad and Lynx cards as well as most third party manufacturers including those based on the AST cluster card and the Digiboard PC/4 and PC/8 cards.

Serial Solutions consists of the following disks and programs.

The Serial Solutions Disk 1 disk contains:-

a) NewCOM.SYS
The dos device driver providing 16 COM ports as with buffered interrupt driven i/o and RS232, 422 and 485 style flow control.

b) NewMODE.EXE
Allows command line reading and setting of baud rates etc for up to 32 ports.

c) EASYC.EXE and EASYC.C
EASYBAS.EXE and EASYBAS.BAS
EASYPAS.EXE and EASYPAS.PAS
Get you up and running in 5 minutes worked examples providing serial terminals with direct COMDEBUG support. Use these FIRST.

d) NewCOM24.SYS
NewCOM32.SYS
Version of Newcom.sys providing support for 24 and 32 serial ports.

The Serial Solutions Utility disk contains:-

a) COMTEST.EXE
ADDRCOM1.EXE
ADDRCOM2.EXE
ADDRCOM3.EXE
ADDRCOM4.EXE
for testing and verifying serial ports and i/o addresses

b) RS232.EXE and RS232.BAS
RS422.EXE and RS422.BAS
RS485.EXE and RS485.BAS
Virtually foolproof but extremely limited communications programs for proving wiring and cable connections.

The Serial Solutions Disk 2 also contains the following in depth worked examples for experienced Serial Solutions users after they have mastered the Easy Disk examples:-

a) BASterm.exe and BASterm.bas
Cterm.exe and Cterm.c
PASterm.exe and PASterm.pas
Aterm.exe and Aterm.asm
FORterm.exe and FORterm.for
5 fully featured terminal emulation programs, with the corresponding source code files,

b) TermTXT.def
A data file used by the terminal emulation programs to specify the properties of the emulated terminal.

c) NewBIOS.com
Loadable replacement BIOS to add Serial Solution BIOS extension features without the DOS device driver capability.

Serial Solutions is designed, written and manufactured in England, and our policy is one of complete support to our dealers and direct to our users. Please note, that Serial Solution is designed 'in house' and is completely understood by the our staff. Its great strength is the support we give it. Our intention is to supply the software and any technical information you may need to allow you to exercise complete control over your serial ports and devices. After searching the manuals, do not hesitate to contact us on our HOTLINE number given on the inside front cover, if you need help.

We are particularly keen to provide new operating system drivers or language examples to expand the range of applications using our software.

We trust that if you adhere to the following procedures you will enjoy many years of useful service from your Serial Solution system.

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Chapter 1

What To Do First.

Introduction.

This chapter explains how to get Serial Solutions up and running as quickly as possible. It starts by showing how install the software to use the standard COM1 and COM2 serial ports, then the configuration is adjusted to allow access to COM3 and COM4. Use of ports COM5 onwards is then explained along with address setting, interrupt line selection for standard serial cards followed by the settings for driving multiport serial cards. Finally the handshaking options that allow RS422 and RS485 cards to be used are dicussed.

The key to trouble free installation is getting the entry in the CONFIG.SYS file right, time spent reading this chapter and the chapter on Newcom.sys command line parameters is well spent.

System Requirements.

Serial Solutions requires the following hardware:-

1) An PC compatible computer running DOS.
2) At least one standard PC serial port.
   This serial port can be either on the main system board or on expansion cards. Up to 32 ports are directly supported. Standard PC serial ports use 8250, 16450 or 16550 compatible uarts. Any mix of RS232, RS422 or RS485 cards may be used. Multiport cards from a variety of manufacturers are supported. Note that intelligent serial port cards, ie those with on board microprocessors are NOT supported.
3) Approximately 100 kilobytes of hard disk space is needed for the minimum installation, 2.0 megabytes is needed if everything is installed.

Up And Running Within Ten Minutes.

This section is intended to get up up and running with Serial Solutions within ten minutes. A more detailed explanation of the component parts of the Serial Solution system follows in later chapters. Since this paragraph is a quick installation, details for COM3 onwards are not being set, so only COM1 and COM2 can be used for the moment.

Outline

1) Copy NewCOM.SYS from Disk 1 to the hard disk.
   COPY A:NEWCOM.SYS C:\ <return>

2) Add an entry for the Serial Solution device driver to the CONFIG.SYS file using an editor such as the MSDOS editor EDIT.
   DEVICE=C:\NEWCOM.SYS

3) Copy NewMODE.EXE from Disk 1 to the hard disk.
   COPY A:NEWMODE.EXE C:\ <return>

4) Copy EASYC.EXE from the Easy Disk to the hard disk.
   COPY A:EASYC.EXE C:\ <return>

5) Reboot the machine by pressing Ctrl-Alt-Del or by switching the power off then back on.
   The Serial Solutions copyright message is displayed on power up. The Serial Solution device driver is now ready for use.

Using COM2.

Assuming that there is a serial port set up as a standard COM2 port present in the PC, the following uses COM2 as a terminal. Data entered at the keyboard with be sent to an attached serial device and any data received will be printed on the PC screen. The external serial device can be a modem or an RS232 terminal connected with a suitable cable.

6) Set the baud rate, parity, stop bits etc to MATCH the

serial device connected to the COM2 port.
NEWMODE COM2:9600,N,8,1 <return> or
NEWMODE COM2:1200,E,7,1 <return> etc.

7) Run the Easyc program using COM2.
EASYC COM2 <return>

Any data type at the keyboard will be sent to the device attached to the serial port. Incoming data from the serial port is displayed on screen.

Within the EASY programs the following keys can be used.
F8 prints the COMDEBUG information on screen
F9 clears the screen
F10 exits back to the DOS prompt.

Serial Solutions Is Up and Running!

Configuring Your System.

The power of Serial Solutions is that many serial ports can be accessed is a simple, unified way. However, Serial Solutions has to be told about your system so that it can use the serial ports that are installed.

For each serial port Serial Solutions has to know the following three pieces of information:-

1) Address. The i/o address of the serial port. ie Where it is in the system.

2) Handshake. The kind of flow control that is being used by the external serial device. The flow control, or handshaking, ensures that no data is lost by only allowing data to be sent or received when the devices are able to accept it.

3) Interrupt.

a) Interrupt on Ordinary Serial Port Cards.
The interrupt line used by the serial port. Ideally each

serial port will have its own unique interrupt line.

or b) Interrupt On Multiport Cards with Interrupt Sharing.
The interrupt sharing system used if the port is on a multiport card that is using a shared interrupt mechanism.
Cards with a shared interrupt line typically have a special register that informs the PC which of its several ports need servicing.

These parameters are passed to NEWCOM.SYS, the Serial Solutions device driver, by command line arguments in the CONFIG.SYS file.
Apart from the standard COM1 and COM2 ports, this information will have to be given for each COM port used by Serial Solutions. The **Address** and the **Interrupt** are physically set on the serial card by jumpers or dip switches. The Serial Solutions address and interrupt must match that actually set on the card.

Setting Up For COM3.

Assuming that the serial port card has been set by jumpers or dip switches to the following:-
COM3 i/o address 03E8 hex using interrupt IRQ 10.

Then the entry in the CONFIG.SYS file would be:-
device=c:\newcom.sys /A3,3E8 /I3,10

If the external serial device can handle data as fast as we can send it then we can assume that no handshaking is necessary. So the entry becomes:-
device=c:\newcom.sys /A3,3E8 /I3,10 /H3,4

The /A3 parameter means the address of COM3 is being set.
The /I3 parameter means the interrupt used by COM3 is being set.
The /H3 parameter means the handshake used by COM3 is being set.

Once the PC has been booted with the COM3 parameters in the CONFIG.SYS file we could now use NEWMODE.EXE and EASYC.EXE with this port.
NEWMODE COM3:9600,N,8,1 <return>
EASYC COM3 <return>

Setting Up For COM4.

In the same way we could add the configuration for a COM4 port using interrupt line IRQ11. The CONFIG.SYS entry becomes:-
device=c:\newcom.sys /A3,3E8 /I3,10 /H3,4 /A4,2E8 /I4,11 /H4,4

COM1-4 Defaults.

Serial Solutions assumes that COM1 is at 3F8hex using interrupt 4 and that COM2 is at 2F8 hex using interrupt 3. This is the industry standard. COM3 is usually at 03E8hex and COM4 at 02E8hex.

Modern PCs can usually find the COM3 and COM4 port addresses and indeed often display them on screen as the PC boots up. In these cases, Serial Solutions will get the COM3 and COM4 addresses directly from the PC's BIOS table and therefore the /A3 and /A4 parameters can be omitted.

However, since there is no fixed standard for the interrupts for COM3 and COM4 ports the /I3 and /I4 parameters must always be passed on the NEWCOM.SYS line in the CONFIG.SYS file.

COM5 And Above.

There are no industry standards for COM5 and above. This means that there is no agreed i/o addresses or interrupts for COM5 or greater. As a result Serial Solutions cannot determine from the PC's BIOS, nor can it assume, how these serial ports have been configured in the PC. Therefor the addresses, interrupt line and handshake type for COM5 and above have to be made

known to the Serial Solutions device driver.

The i/o address, interrupt and handshake used must be specified in the CONFIG.SYS file on the NEWCOM.SYS entry line.

Address Selection.

Each serial port has its address set by jumpers or dip switches on the interface card and occupies 8 i/o consecutive addresses. As explained in the previous section, com ports COM1- COM4 are at standard addresses and so do not need to be explicitly passed to Serial Solutions.

Addresses for COM5 onwards must be passed to the NEWCOM.SYS driver by the /Ar,add parameter.

Where r specifies the COM ports, r may be a single port or a range of ports.

And addr is the address in hexadecimal, suffixed with an optional 'h' or 'H'. For example:-

/A5,1A0 COM5 is at 01A0 hex.

/A5,1A0H COM5 is at 01A0 hex.

/A12,200 COM12 is at 0200hex.

When a range of ports is given, addr specifies the address of the first port in the range, subsequent ports are at 8 byte increments. For example:-

/A8-10,1B0 range of ports is COM8 to COM10 starting at 1B0hex
COM8 is at 1B0hex,
COM9 is at 1B8hex,
COM10 is at 1C0hex.

/A13-,300 range is COM13 to max supported starting at 300hex
COM13 is at 300hex,
COM14 is at 308hex,
COM15 is at 310hex,
COM16 is at 310hex. assuming NewCOM.sys

Always specify the addresses of port COM5 onwards using the /A command in the CONFIG.SYS file.

Interrupt Selection.

For reliable serial communication each serial port needs its own interrupt line. In many ways the interrupt is like the bell on a telephone. When someone is trying to make a call to us our telephone rings. The bell ringing allows us to stop what we are doing temporarily, pick up the phone and deal with the person calling us. After we put the phone down we can carry on where we previously left off. Imagine what it would be like if telephones did not have a bell that rang when an incoming call was received. We would have to constantly pick up the handset and say "Hello. Anyone there?", just in case we had a caller. Most of our time would be spent looking for calls that were not there. Often we would miss incoming calls when we were busy elsewhere or just forgot to check.

Whenever we attempted to send an outgoing call we would waste a lot of time waiting for the person on the other end to pick up the phone and check to see if anyone was there. Most of the time we would fail to get through and so they would miss out on vital information we wanted to pass to them.

The interrupt line connected to the serial port allows the PC to receive data even if the PC is busy doing other things. The interrupt sets off an alarm in the PC causing it to break off what it is doing, grab the incoming data, storing it safely for later, and then continue where it had left off.

If two or more devices are connected to the same interrupt line then the alarm bell in the PC often does not work correctly. One device is trying to set the interrupt bell off whilst another wants it on, the result is unpredictable and data is usually lost.

For reliable serial communication each serial port needs its own interrupt line. The PC has few only a interrupt lines available so adding lots of ports can pose problems.

Multiport cards overcome this problem by having special circuitry on board that prioritises the different ports interrupts and present a single interrupt to the PC, so using few of the PC’s precious resources. See below.

Interrupt lines for COM3 onwards must be passed to the NEWCOM.SYS driver by the /In,i parameter.
Where n specifies the COM port, n may only be a single port NOT a range of ports.
And i is the interrupt line, in the range 2 to 15, used by the port. If i is -1 then this port does not use interrupts. For example:-

/I3,10	COM3 is using interrupt line 10
/I4,11	COM4 is using interrupt line 11
/I5,7	COM5 is using interrupt line 7
/I6,5	COM6 is using interrupt line 5
/I7,12	COM7 is using interrupt line 12
/I2,-1	COM2 is not using interrupts (won't work well with Serial Solutions)

Multiport Serial Cards.

Each serial port we have discussed so far has required its own interrupt line if we want trouble free communications with external devices. As more serial ports are added a fundamental limit of the PC expansion bus slot is reached, there are only 11 interrupts lines available. Of the 16 interrupt line in the PC design only 11 are brought out to the expansion slots, the other 5 are used internally for timers, maths coprocessors etc. The 11 on the slot are reduced to 9 in practice since the floppy disk and the hard disk require one each. If network, SCSI or sound cards are added even less interrupts are available.

It soon seems impossible to add an 8 port card to a PC that already has COM1 and COM2 installed.

To get over the limiting factor of the number of interrupts available many multiport cards have special circuitry on board that allows the ports on the card to share a single interrupt between themselves.

Two interrupt sharing mechanisms have become popular and both these are supported by Serial Solutions.

AST Four Port Card.

The AST Cluster card pioneered a method where a shared interrupt register holds a status bit for each four serial ports. A global status bit is set if any of the four ports have an interrupt pending. This card become popular in the early days of the PC but its inherent non expandability to more than four ports has since caused it to fall into great decline.

The presence of multiple cards using the AST type sharing mechanism, as used on the Flynix and other cards, is passed to Serial Solutions using the /F parameter on the NEWCOM.SYS line in the CONFIG.SYS file.

eg /F 5,3,4,5,6

is used to signify that the AST/ Flynix card is using interrupt line 5, and is sharing it amongst ports COM3, COM4, COM5 and COM6.

Lynx And Quad Cards.

Our Lynx and Quad port cards use the most flexible approach, based on the original Digiboard mechanism. The interrupts from the serial ports goes into shared interrupt circuitry. This presents a single interrupt to the PC, the sharing circuitry also prioritises and encodes the interrupts. There is a shared interrupt service register, the SISR, when read it returns a number between 0 and 255 decimal. If the number read is 255= 0ff hex then no port has an interrupt pending. If the number read is 0 then serial port 1 on the card has generated an interrupt. If the number read is 7 then serial port 8 on the card has generated an interrupt. The interrupts are latched and prioritised so preventing one port locking out the others. A linking mechanism allows multiple four and eight port cards in the one PC to be linked together. Thus giving a theoretical maximum of 255 serial ports in one PC that use only one interrupt line between them. In practice 24 or so ports, using buffered FIFO chips, in a fast PC can provide acceptable performance.

Our Quad and Lynx cards are unique in providing interrupts 2-7, 10, 11, 12, 14 and 15 both for individual ports and also for the shared interrupt.

The presence of multiple cards using this Lynx card type sharing mechanism, as used on the Quad RS232 and the Lynx 8 port RS232, as well as the more limited Digiboard cards, is passed to Serial Solutions using the /L parameter on the NEWCOM.SYS line in the CONFIG.SYS file.
The syntax is:-
/L s, i, r
where

- s is the shared interrupt status register address,
- i is the interrupt line shared by the ports
- r may be a list of single ports or a range of ports

For example the following two lines are equivalent:-
/L 300,15,3,4,5,6,7,8,9,10
/L 300,15,3-10
is used to signify that the Lynx 8 port card has a sisr at 0300hex, using interrupt line 15, shared amongst Com ports COM3, COM4, COM5, COM6, COM7, COM8, COM9, and COM10.
For example:-
/L 3A0,11,5-12
is used to signify that the Lynx 8 port card has a sisr at 03A0hex, using interrupt line 11, shared amongst Com ports COM5 through to COM12.

Handshake Selection.

The handshake used by a port depends on what wires are present in the cable used to interconnect the devices and which pins the wires are joined to at each end of the cable. The cable is often called a 'cross over' cable. Both the PC and the external device have to agree on which handshake method they are using for communications to run smoothly. If the either side uses different handshaking methods either no data will be sent or incoming data will be lost.

In many ways handshaking is similar to the use of traffic lights on a road, the red light stops the flow of traffic, the green

light permits the flow of traffic. Thus a serial port can turn its output signals on or off to indicate to the external device whether data can be received or not. It can use its input signals to sense if the external device is ready to receive more data.

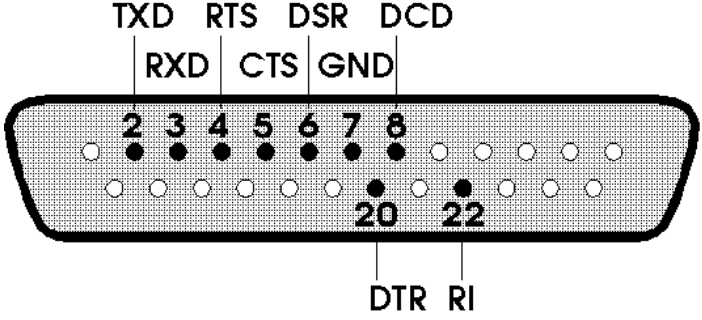
If traffic lights are ignored then crashes will occur. If handshake lines are ignored data will be sent at the wrong time.

If the traffic lights are misread then no traffic at all might flow if a green light is misread as a red light. If handshake lines are misread then serial ports might appear to lock up with no data flowing in or out.

Serial ports have up to 8 signal lines plus a ground line. The number of devices connected together using the one stretch of cable also effects the type of handshake used.

RS232 Handshake Lines.

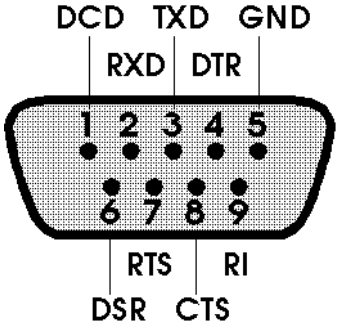
RS232 ports, fitted to virtually all PCs as standard, use 8 signal lines. The RS232 standard is ancient in computer industry terms, introduced in 1962 it is now widely established. It is a slow speed, short distance, single ended transmission system (ie only one wire per signal). Typically RS232 maximum cable length is 50 feet with a maximum data rate of 20K bits per second. RS232 is for data transmitted between only one device and one other.



The original PC's RS232 port was a 25 way D type connector but now PC's usually have a 9pin D type connector.

RS232 signal lines.

TXD,	Transmitted data an output from PC	Data line.
RXD,	Received data an input to PC	Data line.
RTS,	Request To Send an output from PC	
CTS,	Clear To Send an input to PC	Handshake line.
DSR,	Data Set Ready an input to PC	
DCD,	Data Carrier Detect an input to PC	
DTR,	Data Terminal Ready an output from PC	Handshake line.
RI,	Ring Indicator an input to PC.	Used by Modems.



In some RS232 systems the handshake lines are not used or are simply ignored. Only the transmitted data line, received data line and the ground pins need be connected. This method, often called 'the 3 wire handshake', works well only if small amounts of data are sent or if both devices are fast enough to deal with any amount of data received. The '3 wire handshake' assumes that all the traffic lights are always green and that data can be sent at any time.

Every example in this chapter so far has used the '3 wire handshake', so that the PC always believes it can send data. This was specified just to get the data transfer going. The '3 wire handshake' was specified in the NEWCOM.SYS driver by the /Hr,4 parameter. Where r specifies the COM ports, r may be a single port or a range of ports. For example:-

/H1,4 sets up no handshaking for COM1.
/H12,4 sets up no handshaking for COM12.
/H7-16,4 sets up no handshaking for COM7 to COM16.

A common RS232 handshake is the DTR /CTS handshake. Here the traffic light signal is passed out of the PC to the external device on its DTR wire. The traffic light signal from the external device is brought in on the PC's CTS wire.

The PC will only transmit, ie send, data when the CTS input is green, ie logically true. The PC will stop transmitting data when the CTS input is red, ie logically false.

When the PC is able to receive data it will set the DTR output green, ie logically true. When it cannot accept any data it will set the DTR output red, ie logically false.

The RS232 DTR/CTS handshake is was passed to the NEWCOM.SYS driver by the /Hr,0 parameter. Where r specifies the COM ports, r may be a single port or a range of ports. For example:-

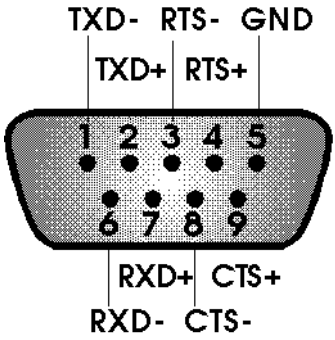
/H1,0 sets up DTR/CTS handshaking for COM1.
/H12,0 sets up DTR/CTS handshaking for COM12.
/H7-16,0 sets up DTR/CTS handshaking for COM7 to COM16.

RS422 Handshaking

RS422 interfaces have less signals than RS232 serial ports, but to reduce noise, while allowing high speeds and long distance transmission, each signal is carried by two wires as a twisted pair, and is thus a differential data transmission system. Over distances up to 40 feet the maximum data rate is 10 Megabits per second, and for distances up to 4000 feet the maximum data rate is 100 Kilobytes per second, allowing communication much further and faster than RS232. Like RS232, RS422 is usually used for data transmitted between only one device and one other, but up to 10 devices can simultaneously receive the transmitted data.

RS422 signal lines.

TXD,	Transmitted data an output from PC	Data line.
RXD,	Received data an input to PC	Data line.
RTS,	Request To Send an output from PC	Handshake line.
CTS,	Clear To Send an input to PC.	Handshake line.



RS422 ports only have a transmitted data line pair, a received data line pair, request to send output line pair and clear to send input line pair.

Therefore the usual RS422 handshake is the RTS /CTS handshake. Here the traffic light signal is passed out of the PC to the external device on its RTS wire. The traffic light signal from the external device is brought in on the PC's CTS wire.

The PC will only transmit, ie send, data when the CTS input is green, ie logically true. The PC will stop transmitting data when the CTS input is red, ie logically false.

When the PC is able to receive data it will set the RTS output green, ie logically true. When it cannot accept any data it will set the RTS output red, ie logically false.

The RS422 RTS/CTS handshake is was passed to the NEWCOM.SYS driver by the /Hr,1 parameter. Where r specifies the COM ports, r may be a single port or a range of ports. For example:-

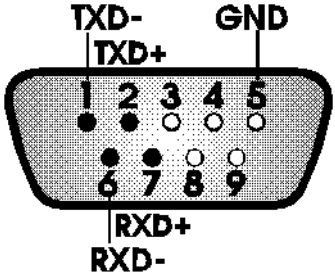
/H1,1 sets up RTS/CTS handshaking for COM1.
/H12,1 sets up RTS/CTS handshaking for COM12.
/H7-16,1 sets up RTS/CTS handshaking for COM7 to COM16.

RS485 Handshake Lines.

The RS485 interface is based in the RS422 standard but have only one or two signals. As in RS422, to reduce noise while allowing high speeds and long distance transmission each signal is carried by two wires as a twisted pair, and is thus a

differential data transmission system. Over distances up to 40 feet the maximum data rate is 10 Megabits per second, and for distances up to 4000 feet the maximum data rate is 100 Kilobytes per second, allowing communication much further and faster than RS232. RS485 allows up to 32 transmitter receiver pairs to be present on the line at one time. If more than one device may transmit data, the PC's RTS line is used as as transmit enable signal, so preventing contention between talkers.

RS485 signal lines.
TXD, Transmitted data an output from PC Data line.
RXD, Received data an input to PC. Data line.



RS485 ports only have a transmitted data line pair, a received data line pair. Frequently, to save having too many wires, the RS485 system shares the transmitted and received data lines.

The RS485 bus is implemented in one of three ways and the handshaking option is set accordingly. These three RS485 implementations are listen only devices, party line half duplex and party line full duplex.

RS485: PC To Listen Only Devices. One cable.

The RS485 listen only device handshake connects one PC to one or mode devices using only ONE twisted pair cable. The transmit lines of the PC are connected to the receive inputs of the devices. The external RS485 devices can only listen to data received from the PC and do not ever reply back to the PC. The PC need only ever transmit data. It does not receive any data. Thus the RS485 card is in transmit only mode, this is handshake

type 3. The RS485 transmit only handshake is passed to the NEWCOM.SYS driver by the /Hr,3 parameter. Where r is the COM port number, r may be a single port or a range of ports. For example:-

/H1,3 sets up 485 transmit only handshaking for COM1.
/H12,3 sets up 485 transmit only handshake for COM12.
/H7-16,3 sets 485 transmit only handshake for COM7 to COM16.

RS485: Party Line Half Duplex. One cable.

The RS485 party line, half duplex handshake connects one PC to one or mode devices using only ONE twisted pair cable. The devices, including the PC, take turns to transmit data along the cable, all can receive the data transmitted. The PC usually is the master controlling the other devices. Each device has its own address and only transmits data when the master commands it to do so. When the PC is not actually in the process of transmitting data, it removes its own transmitters from the bus so allowing the devices to transmit their information down the common twisted pair.

The RS485 party line, half duplex handshake is was passed to the NEWCOM.SYS driver by the /Hr,2 parameter. Where r is the COM port number, r may be a single port or a range of ports. For example:-

/H1,2 sets up 485 half duplex handshaking for COM1.
/H12,2 sets up 485 half duplex handshaking for COM12.
/H7-16,2 sets 485 half duplex handshaking for COM7 to COM16.

RS485: Party Line Full Duplex. Two cables.

The party line full duplex connects a PC to one or more devices using two twisted pair cable. The transmit of the PC goes to the receive input of all the devices, the transmit of the devices is joined together and goes to the receive input of the PC. The PC can transmit data whenever it wishes, even when the devices are transmitting data. The devices take turns to transmit data along the cable. The PC is the master controlling the other devices. Each device has its own address and only

transmits data when the master commands it to do so.

The RS485 full duplex handshake, from a software point of view, is identical to the 3 wire no handshaking option and so is passed to the NEWCOM.SYS driver by the /Hr,4 parameter. Where r is the COM port number, r may be a single port or a range of ports. For example:-

/H1,4	sets up no handshaking (485 full duplex) for COM1.
/H12,4	sets up no handshaking (485 full duplex) for COM12.
/H7-16,4	sets no h/shake (485 full duplex) for COM7 to COM16.

Chapter 2

NewCOM.SYS Config.sys Line Parameters.

Introduction.

This chapter explains the command line parameters used in the CONFIG.SYS file to configure the Serial Solutions device driver NewCOM.sys.

The key to a successful installation is to get the parameter switches right.

Driver Commands.

To install NewCOM a line of the following form must be placed in the machine's CONFIG.SYS file:

device=newcom.sys[/<switch>][/<switch>].....

This section gives details of the command switches, which are used to control the device driver.

Each switch begins with a '/', and has one or more parameters separated by commas. Spaces can be placed anywhere, except in the middle a number. Letters can be either upper or lower case in any mix, so '**/B5**' and '**/b5**' are equivalent. The switches can be placed in any order on the line, and if switches which contradict each other are placed on the line the rightmost switch takes precedence.

Generally the various options default to reasonable values- many users will not need to set any options.

Valid Parameters.

The command line switches take none, one or more parameters. The separator between commands and successive parameters is either a space or a comma. The parameters fall

into the following types, note the port range <range> is of particular interest.

The maximum number of serial ports supported by the driver is known as **maxport**. Different version of the driver support different numbers of ports.

NewCOM.sys supports 16 serial ports so maxport is 16, when NewCOM.sys is being used.

NewCOM24.sys supports 24 serial ports so maxport is 24, when NewCOM24.sys is being used.

NewCOM32.sys supports 32 serial ports so maxport is 32, when NewCOM32.sys is being used.

Figure 2-1. NewCOM Command Summary.

Function	Command Line Switch
Address of port	/A range, hexaddr
Buffer size	/B buffs
Flynix setup	/F irq1, p1, p2, p3, p4, irq2,p5, p6, p7, p8
Handshake	/H [range], [hs]
Interrupt line	/I port, irq
Lynx card setup	/L hexaddr, irq, range[,range][, range]
Omit port	/O range [, range][, range]
Size of buffers	/S memsize
Xon-Xoff	/X range[, xon, xoff]

<port>

A decimal number in the range 1 to maxport specifying a COM port. eg 1 means COM1 10 means COM10.

<range>

A list of none, one or more ports. The each port is a decimal number in the range 1 to maxport. The range can be a singe decimal number, eg 5; a single decimal number and a dash eg -5; a dash and single decimal number, eg 5- or two decimal numbers separated by a dash eg 5-7.

Here are several examples of valid ranges. (using the

Handshake switch).

/H5,4 Serial port COM5 only uses handshake type 4.

/H5-7,4 Serial ports COM5, COM6 and COM7 all use handshake type 4.

/H5-,4 Serial ports COM5, 6, 7 all the way to maxport -the maximum supported by the driver, eg COM16 use handshake type 4.

/H-5,4 Serial ports COM1, COM2, COM3, COM4 and COM5 all use handshake type 4.

<range> [, range]

A list of one or more ranges of ports. Commands for setting up the shared interrupt multiport cards have to define numerous serial ports and so accept a series of ranges.

5-8,10-12,14- Serial ports COM5 to COM8 and COM10 to COM12 and COM14 to the maximum supported by the driver.

-4,7,9-11 Serial ports COM1 to COM4, COM7 and COM9 to COM11

<irq>

A decimal number in the range 2-15, specifying a PC bus interrupt line.

/I3,10 Serial port COM3 is using interrupt 10.

/I4,11 Serial port COM4 is using interrupt 11.

<hs> One decimal number in the range 0-4 used to specify which software flow control method is in use.

<hexaddr>

An hexadecimal word in the range 0000h-0FFFFh, this is used to specify the i/o address of a serial port. The word must start with a number 0-9 or a-f. The address may have an optional ’h’ or ’H’ suffice.

/A1,03F8 Serial port COM1 at address 03f8 hex.

/A2,2f8 Serial port COM2 at address 02f8 hex.

/A5,1B0h Serial port COM5 at address 01b0 hex.

<memsize>

A decimal number in the range 2-32768, rounded down to the nearest power of 2. Used to set the size of the interrupt driven i/o buffer.

<buffs>

Decimal number in the range 1 - maxport. Used to specify the number of buffers to allocate. Each interrupt driven port needs its own buffer so this also sets the maximum number of ports that can be used in interrupt mode.

Driver Defaults.

When no switches are specified in the config.sys file the following defaults are used:

I/O Addresses.

Only those ports found by the power on ROM BIOS check are set up automatically.

On all PC compatibles the ROM BIOS checks for COM1 and COM2 at their usual I/O addresses, 03F8H and 02F8H respectively so these ports are automatically recognised.

On most modern machines the ROM BIOS also checks for COM3 at 03E8H and COM4 at 02E8H.

IBM PS/2 machines with the micro channel bus have COM3 at 3220 and COM4 at 3228.

Interrupt Lines.

COM1	**4**
COM2	**3**
COM3-	**-1 (meaning none set)**

Multiport Cards.

No multiport cards are assumed to be present.

Hardware Handshake.

All ports default to H4, the 3 wire No Handshake, that is ports are always ready to send and receive data.

Software Handshake.

XON/XOFF handshaking is disabled, XON is 17, XOFF is 19, should software handshaking be turned on.

Buffer Size.

Buffers are 256 bytes long.

Buffer Number.

The maximum number of pairs of buffers is 6 (that is up to six ports can use interrupt driven buffered i/o).

Baud rate etc.

All ports recognised by the ROM BIOS are reset to 2400 Baud, no parity, 8 data bits and one stop bit when the machine is powered up.

All ports whose address is set in the config.sys file are also set to 2400 baud, no parity, 8 data bits and 1 stop bit. The other ports, not recognised by Serial Solutions at boot time, are reset by the PC's hardware at power up to no parity, 5 data bits and one stop bit.

Buffer enabling.

When the machine is rebooted the buffers for all ports whose address has been found by the BIOS or set in the config.sys file are allocated. This is up to the limit set by the /B command.

I/O Address.
Switch: **/A range,hexaddr**
Purpose:
Set the I/O address of serial port COMn.
'range'
'range' must be given. Range specifies the COM ports, range may be a SINGLE port OR a RANGE of ports.

'hexaddr'
is the address of the port, it must be in hexadecimal, suffixed with an optional 'h' or 'H'.

Single port examples:- (old method:- still works)
/A5,1A0 COM5 is at 01A0 hex.
/A5,1A0H COM5 is at 01A0 hex.
/A12,200 COM12 is at 0200hex.

When a range of ports is given, hexaddr specifies the address of the first port in the range, subsequent ports are at 8 byte increments. Range port examples:- (new method:- less typing, easy to understand)
/A8-A10,1B0
port range is COM8 to COM10 starting at 1B0 hex
COM8 is at 1B0hex,
COM9 is at 1B8hex,
COM10 is at 1C0hex.

/A13-,300 range is COM13 to maxport, starting at 300hex
COM13 is at 300hex,
COM14 is at 308hex,
COM15 is at 310hex,
COM16 is at 310hex. assuming NewCOM.sys
NEWCOM.SYS supports up to 16 COM ports.
NEWCOM24.SYS supports up to 24 COM ports.
NEWCOM32.SYS supports up to 32 COM ports.

Number Buffers.
Switch: **/B buffs**
Purpose:
Set number of pairs of buffers to be allocated.
buffs
is a decimal number in the range 1-maxport and is the number of buffers to allocate. Each interrupt driven port needs its own buffer so this also sets the maximum number of ports that can be used in interrupt mode.
Always ensure that there is one for each port in use.

NewCOM reserves space for the buffers from main memory when the machine is booted. Each port whose address is known at boot time either by the being recognised by the ROM BIOS or whose address is set in the config.sys file have a buffer allocated to them when NewCOM.sys loads, provided sufficient are defined using the /B command.
For example
/B 9 reserves 9 buffers, one for the built in COM1 port and one each for the 8 ports on the Lynx card.

For example
/B 4 reserves space for four pairs of buffers, enough for four serial ports.

The default is six pairs. The buffer allocated contains an equal amount of room for both the incoming data and the out going data.

Hardware Handshake.

Switch: **/H [range],[hs]**

Purpose:

Select which hardware handshake type to use on the specified ports. Hardware handshake is flow control of data determined by the state of various lines in the port connector. See chapter "What To Do First", section "Handshake Selection" for more information.

'range'

specifies the COM port. Range may be a SINGLE port OR a RANGE of ports. If range is not specified the handshake is applied to all serial ports.

'hs' is a number indicating the type of handshake, and 4 is the default. This does not override a previous XON/XOFF setting, in conjunction with which it may be used. The types are listed below.

The hardware handshake currently supported are:

Type 0 RS232 DTR/CTS

The PC only transmits when CTS is input true. When the PC is able to receive its sets DTR output true.

The DSR and DCD inputs are ignored. The RTS output line is set true just in case the external serial device needs a true signal.

Type 1 RS422 RTS/CTS

The PC only transmits when CTS is input true. When the PC is able to receive its sets RTS output true.

The DSR and DCD inputs are ignored. The DTR output line is set true just in case the external serial device needs a true signal.

Type 2 RS485 Half duplex

Before any data is sent the PC sets RTS true, after the last byte in the buffer has been sent the PC sets RTS false. RTS is used as a transmit gating control.

The CTS, DSR and DCD inputs are ignored. The DTR output line is set true just in case the external

serial device needs a true signal.

Type 3 RS485 Send only.
This is a half duplex, transmit only handshake.
The PC transmits whenever it wishes, it cannot receive any data.
The CTS, DSR and DCD inputs are ignored. The RTS output line is set true just in case the external serial device needs a true signal.

Type 4 3 Wire Handshake.
Really no handshake at all since the PC transmits irrespective of the handshake lines.
The 3 wires are TxD, RxD and Ground, no other lines are required. Thus the CTS, DSR and DCD inputs are ignored. The RTS and DTR output lines are set true just in case the external serial device needs a true signal.

Single port examples:-
/H1,2 Set COM1, handshake 2
/H,1 Set handshake 1 for all ports
The /H switches are processed from left to right, so for example
/H,2 /H1,0 /H2,1
would set COM3 to COM16 to handshake type 2, COM1 to type 0 and COM2 to type 1.

When a range of ports is given, every port port in the range is set to the specified handshake value.
Range of port examples:-
/H7-16,4 sets up handshake type 4 =no handshake for COM7 to COM16.
/H3-5,2 sets up handshake type 2 CTS/RTS for port COM3, COM 4 and COM5.

Hardware Interrupt.
Switch: **/I port, irq**
Purpose:

Set interrupt line is use with the COM port. With the exception of specially designed shared interrupt cards like the Lynx & Quad RS232 cards, for reliable communications each port needs its own interrupt line.

'port'

a decimal number in the range 1 to maxport specifying a COM port. eg 1 means COM1 10 means COM10. If port is not specified the interrupt line is applied to all ports.

'irq' is the interrupt line in the range 2 to 15, or, to indicate no interrupt line, -1 or nothing.

Figure 2-2. Interrupt Allocation.

IRQ	NORMAL USE	COMMENTS	STATUS
2	VGA GRAPHICS CARD	Used by very few VGA cards	Usually OK
3	COM2	Dedicated to COM2 at 2F8hex	COM 2 ONLY
4	COM1	Dedicated to COM1 at 3F8hex	COM 1 ONLY
5	LPT 2	DOS/WIN don't use this IRQ Avoid with OS/2 Novell WinNT	Good in DOS & Windows
6	FLOPPY DISK	Dedicated to Floppy Disk	AVOID !!!
7	LPT 1 Soundblaster	DOS/WIN don't use this IRQ Avoid with OS/2 Novell WinNT	Good in DOS & Windows
10	Usually Free	Recommended for COM3	GOOD
11	Usually Free Adaptec SCSI	Recommended for COM4 if not Adaptec SCSI card	GOOD
12	POINTING DEVICE	Free if Mouse is on COM port	Usually OK
14	IDE HARD DISK	Usually In Use. Free when SCSI disks in use	Usually BAD
15	Usually Free	Recommended	GOOD

A serial port must be assigned an interrupt line before it can be used. On ISA bus PC compatibles machines and EISA bus machines only one serial port can use an interrupt line. On PS/2 machines serial ports can share interrupts. Multiport cards with special interrupt hardware have different rules- see the /L command switch (also /F) for setting up those cards.

Each serial port needs its own interrupt line for trouble free performance, if two serial ports are allocated the same IRQ line only one can use it at any time. NewCOM allows one port to use the IRQ line, and any others allocated that line are polled. For DOS and Windows 3.x use, after COM1 and COM2 installed, then IRQs 5, 7, 10, 11, 12 and 15 are available.

For example

/I1,4	set COM1 to use irq line 4
/i,-1	sets all ports to no interrupt
/i2,	sets COM2 to no interrupt
/I1,4	set COM1 to use irq line 4
/I3,10	set COM3 to use irq line 10
/I4,11	set COM4 to use irq line 11
/I5,12	set COM5 to use irq line 12
/I6,15	set COM6 to use irq line 15

Lynx 8 Port and Quad RS232 cards.
Switch: **/L hexaddr, irq, range [, range] [, range]**

The shorthand allowed in using port ranges with the Lynx command, as well as the port Address and Handshake commands, allow a multiport system to be setup by only a few short entries in the NewCOM.SYS line in the CONFIG.SYS file.

The older notation, without ranges, where every port is explicitly defined can still be used but is more cumbersome.
Switch: /L hexaddr, irq, p1, p2, p3, p4, p5, p6, p7, p8...

Purpose:
Set up one or more Lynx 8 port or Quad port serial cards.
The /L command has superceeded the /D command.

'hexaddr'
is address of the SISR, Shared Interrupt Status Register.
'irq' is the interrupt line set on the Shared IRQ jumper block.

'range'
specifies the COM port. Range may be a SINGLE port OR a RANGE of ports. Each port is a decimal number between 1 and maxport. Multiple ranges may be specified, if necessary, to define all the ports in use.

Range port examples:- (new method:- less typing, easy to understand)

/L 03A0, 12, 3-10
Lynx card with Shared Interrupt Status Register, SISR, at i/o address 03A0 hex, Interrupt 12 is the shared interrupt,
Lynx port#1 is mapped as COM3
Lynx port#2 is mapped as COM4
Lynx port#3 is mapped as COM5
Lynx port#4 is mapped as COM6
Lynx port#5 is mapped as COM7
Lynx port#6 is mapped as COM8
Lynx port#7 is mapped as COM9
Lynx port#8 is mapped as COM10

Note: Ports on a Lynx or Quad port card that are using interrupt sharing MUST be configured with the /L command line switch rather than the /I switch. Ports on a Lynx or Quad card that are not using the shared interrupt but have their own separate interrupt must be configured with the /I command switch.

’p1’, ’p2, etc. Older notation.

p1 etc are the COM port allocated to each serial port on the Lynx card. For example if p1 is ’3’, then port 1 on the card will be accessed as COM3. The COM3 i/o address, ie the address of the Lynx card port#1, is specified elsewhere on the CONFIG.SYS file line, using the /A3 switch. The ’p’ places can be empty, indicating those ports on the card that are not being set up to use the shared interrupt mechanism.

Defining the ports using 8 separate port numbers is now equivalent to using 8 single port ’ranges’.

Older notation example:-

/L 300,7,3,4,5,6 Quad port card.

/L 300,7,3-6 Equivalent new notation.

Quad card with Shared Interrupt Status Register at 0300H, sharing interrupt 7, Quad port#1 is COM3,
Quad port#2 is COM4,
Quad port#2 is COM5,
Quad port#2 is COM6.

Older notation example:-

/L 03A0,3,2,3,4,5,6,7,8,9 Lynx 8 port card.

/L 03A0,3,2-9 Equivalent new notation.

Lynx card with Shared Interrupt Status Register, SISR, at i/o address 03A0 hex, interrupt 3 is the shared interrupt,
Lynx port#1 is mapped as COM2
Lynx port#2 is mapped as COM3
Lynx port#3 is mapped as COM4
Lynx port#4 is mapped as COM5
Lynx port#5 is mapped as COM6

Lynx port#6 is mapped as COM7
Lynx port#7 is mapped as COM8
Lynx port#8 is mapped as COM9

If more than one Lynx card is installed in the machine then these can be linked together as shown in the cards' installation manual, in which case they would share the SISR, shared interrupt status register and interrupt line of the first card. Install this combination as a single card, with one /L switch.

Older notation example
/L 03A0,3,2,3,4,5,6,7,8,9,10,11,12,13 '12' port card.
/L 03A0,3,2-12 Equivalent new notation.

Lynx card with Shared Interrupt Status Register, SISR, at i/o address 03A0 hex, Interrupt 3 is the shared interrupt,
Lynx card 1 port#1 is mapped as COM2
Lynx card 1 port#2 is mapped as COM3
Lynx card 1 port#3 is mapped as COM4
Lynx card 1 port#4 is mapped as COM5
Lynx card 1 port#5 is mapped as COM6
Lynx card 1 port#6 is mapped as COM7
Lynx card 1 port#7 is mapped as COM8
Lynx card 1 port#8 is mapped as COM9
Lynx card 2 port#1 is mapped as COM10
Lynx card 2 port#2 is mapped as COM11
Lynx card 2 port#3 is mapped as COM12
Lynx card 2 port#4 is mapped as COM13

Alternatively, the cards can be installed separately, each card using its own status registers and interrupts. Note that although linked cards can share interrupts, separate cards cannot share any interrupt line.

Older notation example Two 8 port card.
/L 03A0,3,2,3,4,5,6,7,8,9 1st card SISR at 03A0
/L 0300,7,10,11,12,13,14,15,16,17 2nd card SISR at 0300
/L 03A0,3,2-9 Equiv new notation 1st card.
/L 0300,7,10-17 Equiv new notation 2nd card.

Omit Port From Serial Solution Control.
Switch: **/O range**
Purpose:

Prevents Serial Solutions from managing that port. If you wish a mouse driver or the default DOS handlers to control a serial port then remove that port from serial solutions control.

'range'

'range' must be given. Range specifies the COM ports, range may be a SINGLE port OR a RANGE of ports.

Single port examples:- (old method:- still works)
/O1 COM1 not under Serial Solutions control.
/O2 COM1 not under Serial Solutions control.

Range port examples:-
/O8-10

Ports COM8 to COM10 outside Serial Solutions control.

/O13- range is COM13 to maxport (=16 with NewCOM.sys).
COM13 to COM16 not under Serial Solutions control.

Buffer Size.
Switch: **/S memsize**
Purpose:

Set size of all buffers in bytes, memsize is rounded to the nearest power of 2, and must be a decimal number in the range 32 to 32768. For any serial port opened two buffers of size memsize are allocated, one for input and the other for output. The space for the buffers is reserved by the driver when the machine is booted, and, provided an address has been set for the port either by being recognised by the ROM BIOS or by having its address set in the config.sys file the buffer is allocated to the port when NewCOM.sys loads.
The NUMBER of buffers, of size memsize, allocated is set by the /B command switch.
Example:-
/S 512 sets the buffer size to 512 bytes. The default size is 256 bytes.

Note that in actual operation only memsize-1 bytes are available, so the default buffer, nominally 256 bytes long, can only hold 255 bytes.

Xon-Xoff Handshaking.

Switch: **/X [range] [,xon,xoff]**

Purpose:

Set port COMn to XON/XOFF handshaking. In this mode the hardware handshake lines are ignored and the characters XON and XOFF are used to control the flow of characters on the serial line.

'range'

specifies the COM port. Range may be a SINGLE port OR a RANGE of ports. If range is not specified the XON/XOFF handshake is applied to all serial ports.

'xon, xoff'

The optional parameters XON and XOFF are decimal numbers which are to be used as the XON and XOFF characters. Their default values are 17 (DC1) and 19 (DC3) respectively.

Single port example:

/X2 XON/XOFF handshake used by COM2

/X3,18,20 XON/XOFF handshake used by COM3
Data flow started by char code 18 and stopped by char code 20.

If the port range is not given, then XON/XOFF handshaking and any specified handshake characters are set for all ports, as

/X XON/XOFF handshake used by all ports.

/X,18,20 XON/XOFF handshake used by all ports.
Data flow started by char code 18 and stopped by char code 20.

When a range of ports is given the XON/XOFF handshake applies to all the ports within the specified range.

Range port examples:- (new method:- less typing, easy to understand)

/X-4 XON/XOFF handshake used by COM1 to COM4.

/X8-10 XON/XOFF handshake used by COM8 to COM10.

/X13- XON/XOFF handshake used by COM13 to maxport.
eg NEWCOM.SYS supports up to 16 COM ports.

XON/XOFF Handshake.

In the XON/XOFF handshake two characters are assigned a special meaning by the serial port. One, called XON, is sent by a device to signal that it is ready to receive data. The second, called XOFF, is sent when the device can no longer receive data. NewCOM therefore traps XON and XOFF characters as they arrive and uses them to switch on and off the output of characters. The user will not detect these characters. Interrupt driven input sends an XOFF when the input buffer is nearly full, and an XON when the buffer is emptied to restart the remote device transmitting. Interrupt output is halted when an XOFF is received, and restarted when an XON is received.

Beware!

The driver does not check the data sent to it by the user for XONs or XOFFs, which means that they are sent over the serial line. The remote device **will** interpret these as XON and XOFF, forcing it to stop and start transmissions. Likewise if the user tries to send data which contains XONs and XOFFs to the PC it will interpret them as such. This will not be a problem with text data, which generally does not use the usual XON and XOFF characters. Binary data could though be a problem, so look out for the symptoms-data lost as buffers overflow, and odd bytes lost because their values were the same as XON and XOFF.

Chapter 3

Using NewMODE.

Introduction.

NewMODE is a replacement for the DOS 'mode com...' command which supports some of the extra features available under NewBIOS and NewCOM. It enables the user to set the baud rate parity, word length and number of stop bits of a serial port, and a query mode allows the user to find the settings of one or all ports. The i/o address and interrupt line can also be set with the newmode command.

Command Format.

In the descriptions which follow a string of characters enclosed in angled braces <thus> indicates a symbol which should be replaced by a string defined later. Optional parameters are enclosed in square braces [to indicate that they don't necessarily have to be included]. Alternatives are enclosed in curly braces and separated by vertical bars as **{one|or another|but not both}**. Note that spaces are important, for example the line

c>**newmode com1:1200 ,e,7,1**

which is a legal syntax for the DOS mode command, will prevent further use of COM1. Use only the spaces shown in the syntax, and check them against the examples if you're still not sure.

NewMODE can be used in three main ways: help, parameter setting (like the DOS mode com command) and query.

Help.

To obtain help on the NewMODE command type:

c>**newmode**

This returns a brief description of the command syntax.

Parameter Setting.

This mode nearly mimics the DOS 'mode com' command, and allows the user to set the parameters (for example baud rate, parity) of a port.

The command takes several parameters, firstly the port, then a group of parameters defining the baud rate, parity, number of data bits (word length) and the number of stop bits (these separated by commas), then an optional i/o address and an irq line number separated by spaces.

Note: The ability to set the i/o address and irq numbers using NewMODE is for backwards compatibility with previous versions of Serial Solutions. From version 2.00 onwards these parameters should only be set in the CONFIG.SYS file using the /A and the /I commands, or the /A and /L commands for multiport cards, on the device= NewCOM.SYS line.

The format is:

c>**newmode COM<n>[:<params>] [<address> [<irq>]]**

where

<n> **= 1...16** is the serial port number, as in 'COM4'.
= range 1 to 32 when NewCOM32.sys is used.

<params>
=[<baud>[,<parity>[,<databits>[,<stopbits>]]]] are the parameters that define the serial port.

<baud> is the Baud rate
=one of **110, 150, 300, 1200, 2400, 4800, 9600, 19200, 38400, 57600, or 115200**

<parity> is the parity option
=**n, o, e, m, or s**
for none, odd, even, mark and space respectively.

<databits> is the number of bits per word sent.
=**5, 6, 7 or 8**

<stopbits> is the number of stop bits appended to the data
=**1 or 2**

<address> **Backwards compatibility only**

is a hexadecimal I/O address in the range 0 to FFFF
eg 03f8 for COM1, 02f8 for COM2, 02e8 for COM3
Note: Do not set the i/o address this way.
Use /A on the device= NewCOM.SYS line in CONFIG.SYS file.

<irq> **Backwards compatibility only**

2...15 or **-1** is the interrupt line to use.
Note: Do not set the irq this way.
For standard serial ports use /I command on the device= NewCOM.SYS line in CONFIG.SYS
For shared interrupt multiport serial cards use /L command on the device= NewCOM.SYS line in CONFIG.SYS file. file.

Since the <address> and <irq> settings have been superseded by switches in the CONFIG.SYS file, only the communications parameters, <params> should be given with the newmode command. The <params> specified may be none, any or all of the <baud>, <parity>, <databits> or <stopbits> options. Unspecified values are replaced with defaults as follows:

Baud rate	1,200
parity	even
databits	7
stopbits	1 (or 2 for 110 baud)

Examples.

c>**newmode com1:300**
sets COM1 to 300 baud, even parity, 7 data bits and 1 stop bit.

c>**newmode com3:11,n,8**
sets COM3 to 110 baud, no parity, 8 databits and 2 stop bits.

c>**newmode com2**
sets COM2 to 1,200 baud, even parity, 7 databits & 1 stop bits.

NewMode Differences From DOS 'mode com'.

1) The ':' must be present if any parameters are given, for

example 'COM296,e,7,,' is legal for DOS mode, but not for NewMODE.

2) DOS does not support above COM4.
3) Newmode also supports COM17 to COM32 when NewCOM32.SYS is used, while DOS does not.
4) DOS mode does not give a default Baud rate, where newmode does.
5) Newmode does not support the 'P' option that DOS mode offers if the port is to be connected to a printer and assigned to LPT.

Query.

This reports the current state of one or all of the serial ports. The syntax is:

c>**newmode [COM<port>] <queryflag>**

where

<port> is **1...16**, the COM port, eg COM11.
<queryflag> is **?** or **query**

If a COM port is specified then a report for that port alone is generated. If no port has been specified then a report on all the ports is generated. The report for each port is a line in exactly the same format as a NewMODE setting command. This allows the output of the query to be redirected to a batch file which can be run later to restore to state of the ports.

Examples.

c>**newmode com1 query** generates the reply

NEWMODE COM1:1200,n,8,1 3F8 4

c>**newmode ?** generates

NEWMODE COM1:1200,n,8,1 3F8 4
NEWMODE COM2:2400,n,8,1 2F8 3
NEWMODE COM3:300,n,7,1 3E8 3
NEWMODE COM4:1200,e,7,1 2E8 3
NEWMODE COM5 0
NEWMODE COM6 0
NEWMODE COM7 0

```
NEWMODE COM8 0
NEWMODE COM9 0
NEWMODE COM10 0
NEWMODE COM11 0
NEWMODE COM12 0
NEWMODE COM13 0
NEWMODE COM14 0
NEWMODE COM15 0
NEWMODE COM16 0
```

c>**newmode ? >oldmodes.bat** creates a disk file called 'OLDMODES.BAT' and sends the report in the example above to it. If the command oldmodes is given:-

c>**oldmodes** will set COM1 to COM4 as set above.

The exact content of these reports of course will depend on how your system is set up and how many serial ports are installed.

Using NewMODE Without NewBIOS.

If neither NewCOM.sys or NewBIOS have not been installed and NewMode is being run with only DOS then NewMODE will do its best to meet the requests made of it via the standard PC ROM BIOS, reporting address and baud rates for up to the first four COM ports.

Help.

This still works, reports the reduced functionality available.

Parameter Setting

Parameter and address settings work exactly as before, but only COM1, COM2, COM3 and COM4 are supported. Setting the IRQ line is of course meaningless, because there is no record to set and no driver to use the IRQ line.

Query

This works as normal, with the reduced range COM1 to COM4. The IRQ settings reported are the defaults industry standards, IRQ4 for COM1 and IRQ3 for COM2.

Chapter 4

Using NewBIOS.

Introduction.

NewBIOS is an INT14 upgrade that is installed automatically by the device driver NewCOM.SYS, NewBIOS provides extra function calls designed to make serial i/o easier.

Since a few users may wish to NewBIOS as a stand alone program and the NewBIOS.com program is provided on the Serial Solution disks. The NewBIOS.com program ONLY needs loading if you have chosen not to load NEWCOM.SYS in the CONFIG.SYS at boot time.

The ROM BIOS.

PC compatible computers share a wealth of software supplied in the machine's ROM, the ROM BIOS (Basic Input-Output System). This provides services to assist the operating system and applications programs in using the hardware of the machine.

One group of services is provided to manage the computer's serial communication ports (RS232 ports). These are called the **asynchronous communications services**, and will set parameters such as baud rate, send characters, receive characters and report the status of the ports. The asynchronous services are however limited to only four ports, leaving a machine with more ports 'out in the cold'. Hence the need for NewBIOS. The code of NewBIOS replicates the functions of the ROM BIOS but allows up to 32 ports to be used, and adds functions to support the extra cards and the device driver NewCOM which uses them.

NewBIOS is installed either by the device driver NewCOM or by running the program NewBIOS.com. Both 'patch' interrupt 14H, through which the ROM asynchronous services are accessed, so that any program which attempts to use the ROM

services is referred instead to our routines.

To sum up, if the user loads NewCOM or runs NewBIOS the ROM serial communications routines are replaced by the routines of NewBIOS. These allow up to 16 serial ports to be used and add several extra functions.

Overview Of Asynchronous Services.

NewBIOS mimics all the services provided by the ROM BIOS of the PC and the extra facilities of the PS/2 ROM BIOS. These functions are extended to cover 16 ports and service 4H, the PS/2 extended initialise, supports extra baud rates. The services are as follows. Note that the service numbers are in hexadecimal, and all services except AEH are directed towards specific ports.

Service 0H, Initialise communications port.

This sets the port parameters. These are the baud rate, parity, number of stop bits and word length.

Service 1H, Send character.

Send a single (usually ascii) character to the port.

Service 2H, Receive character.

Receive a single character from the port.

Service 3H, Read status.

The state of the RS232 handshake input lines and the status of the serial chip (including things like reception errors, chip ready to send data) are returned. The other standard services return some or all of this information anyway.

Service 4H, Extended initialise.

Provided on the PS/2 ROM BIOS (and on NewBIOS for all PCs), this performs a similar function to service 0H, but allows a wider range of parameters to reflect the full capabilities of the serial chip and is somewhat easier to use. The NewBIOS version extends the ranges of baud rates available still further.

Service 5H, Extended communications port control.

This allows us to read, via subservice 0, the state of the

RS232 handshake output lines, and to to set them via subservice 1.

NewBIOS adds seven completely new services. These are.

Service ADH, Set port address.

Serial chips at the standard addresses defined by IBM for COM1 and COM2 are automatically recognised by the ROM BIOS (and hence NewBIOS) when the machine is powered on or reset, but NewBIOS must be told of the existence of chips at other addresses. This service returns the address previously attributed to the port. It also returns particular values as flags, so that this service can be used to check for the presence of NewBIOS. The program 'NewBIOS.com' uses this method to decide whether or not to install NewBIOS.

Service AEH, Get number of ports.

The number of ports set up (ie with valid addresses) is returned.

Service AFH, Get/Set IRQ line.

This service exists to support NewCOM, which can use interrupts for more convenient and efficient serial input/output. Subservice 0 returns the IRQ line which a particular com port is assumed to be using, and subservice 1 sets this. Ports COM1 to COM8 are given default values (which may need to be altered), but ports COM9 onwards must be explicitly set before NewCOM can use them in interrupt mode.

Service B0H, Get/Set Hardware Handshake.

This service exists to support NewCOM, which can use several different hardware handshakes. The hardware handshake is the way that the control lines associated with a serial port are used. The input lines (CTS, DSR, DCD and RI) are checked to ensure that it is ok to send data out, and the output lines (RTS and DTR) are set to say whether the driver has space to read any more data. The handshake selected by this service defines which lines are used, and how. This service also returns a flag to show whether the driver is present, as opposed to simply

NewBIOS.

Service B1H, Get/Set Software Handshake.

This service exists to support NewCOM, which can use software handshakes. A software handshake uses special characters, conventionally called XON and XOFF, to control the flow of data. This is to be compared with a hardware handshake, where control lines fulfil the same purpose. Subservices 0 and 1 allow software handshaking to be turned on and off, and subservices 2 and 3 allow the actual characters to be used as XON and XOFF to be changed.

Service B2H, Get/Set Card Type.

This service exists to support NewCOM, which can use non-standard serial cards. The inherent limitation of the serial ports on a standard IBM PC or clone is the number of ports that can use buffered i/o. Many cards are therefore manufactured which circumvent this limitation. These require special treatment, and this service tells the device driver that the port specified is on a special card, and supplies any relevant additional information.

Service B3H, Get/Control Buffers.

This service exists to support NewCOM, which can use buffered i/o for more convenient and efficient serial input/output. Subservices 0 and 1 read the status of the buffers associated with a port. Subservices 2 and 3 flush the buffers. Subservices 4,5,6 and 7 can disable/enable the buffers for a port.

The next chapter lists comprehensive details of all NewBIOS services. The following sections of this chapter cover the use of the services, and will introduce details of particular services only as necessary. This is not intended as a comprehensive tutorial in serial communications, rather it will demonstrate how to use NewBIOS.

Installing NewBIOS.

There are two ways to add NewBIOS to your system. For

most users NewBIOS is loaded automatically when the NewCOM.sys device driver is loaded in the CONFIG.SYS file. This allows DOS, and hence applications, easy access to COM3 through to COM16. To do this the following line must be included in the machine's config.sys file:

device=newcom.sys

When the machine is powered on or reset DOS examines the file called config.sys and installs the named file as a device driver.

An alternative method, for those very few users who do not wish to use NewCOM is to run the program NewBIOS.com. This checks for the presence of NewBIOS, and installs it if it is not already present. The command is therefore:

c>**newbios**

The command 'newbios' can be placed in the machine's autoexec.bat file so that every time the machine is rebooted NewBIOS is installed.

Accessing Asynchronous Services.

Once installed the BIOS services can be accessed by user programs written in many languages. This manual covers in detail Assembly language, C, Turbo Pascal, GW-BASIC/BASICA, QuickBASIC, Visual Basic for Dos and Microsoft FORTRAN. We will first discuss the use of the services from the viewpoint of assembly language programs and then demonstrate how other languages do the same task. This approach has been adopted because the nature of the BIOS services means that a whatever language a programmer uses to access them they must still appreciate how the services operate at the machine level. Anyone already well acquainted with PC assembly language will probably not need to be told how to use the services, so this discussion will be aimed at the non-expert. Anyone who is vaguely familiar with binary and hexadecimal (written in the form 'XXH') numbers should not find any problems understanding it.

All BIOS services are interrupt routines. Interrupt routines are run when a hardware interrupt occurs of when the 8086

processor executes an 'INT n' instruction. The number 'n', in the range 0 to 255, defines which interrupt routine to use. The addresses of the 256 interrupt routines are stored in a table in the PC's memory which the processor reads to find the correct program to run on an interrupt. So the instruction 'INT n' causes the processor to read the nth address and then run the routine stored there. Each address takes four bytes, so the address of interrupt 14H, which the asynchronous services interrupt, is at 50H (14H multiplied by 4). When the machine is started this is set to the address of the ROM BIOS' asynchronous services. When NewBIOS is installed it's code is placed in the PC's memory and the address is set to point to it.

The assembly language code to call the asynchronous services is therefore:

```
INT 14H
```

Note that this will call the ROM BIOS routines unless NewBIOS has been installed. The program cannot choose which to call, nor can it tell which has been called except by examining the results of the call.

The asynchronous services are controlled by the values which are present in the 8086's registers when the interrupt occurs, and report back to the program by setting values in those registers.

Aside On The 80x86 Registers Set.

A register is part of the processor which can store a number, and assembly language instructions refer to these registers for arithmetic, storage etc. The four general purpose registers used to communicate with the asynchronous services are AX, BX, CX and DX. Each of AX...DX is 16 bits wide (that is large enough to store numbers in the range 0 to 65535), but can alternatively be viewed as pairs of 8-bit-wide registers (each valid for numbers from 0 to 255). The 8-bit registers are called AH and AL (short for AX high and AX low) from AX, BH and BL from BX, CH and CL and DH and DL. Within each register the bits are number from 0 to 7 for an 8-bit register, and from 0 to 15 for a 16-bit register.

The main registers used to control the asynchronous services are:

AH The AH register is set to the number of the asynchronous service required.

DX The number of the port to use. 0 means COM1, 1 means COM2 etc.

AL, BX, CX
Other control information, depending on the service.

Returns from the services depend on the particular service.
For example for services 0H to 5H:

AH Line status, details of receiver errors, whether bytes are ready to be sent/received.

For services 0H,3H to 5H:

AL Modem status, the values of the four RS232 handshake inputs, and whether or not they have changed since last read.

8086 Assembly Language.

This section contains three examples of the use of BIOS services from assembly language. Anyone not immediately familiar with accessing interrupts from assembly language should refer to the previous section, 'accessing asynchronous services'.

BIOS access from assembly language is fast and efficient, allowing assembly language programs to easily control serial ports.

Example 1, Initialising A Port.

This is a simple example that will demonstrate some of the above points. It uses service 0H to set up the baud rate etc for COM1, typically the first task of a program which performs serial input/output.

```
;Code fragment to set up RS232 port to 1200 baud,
;even parity, 1 stop bit and 7 data bits.
;
;
mov ah,0H               ;Mov the value '0' to the AH register.
                        ;Use service 0, initialise.
```

```
mov al,09AH             ;09AH indicates the above parameters.
                        ;later chapters contain details of
which
                        ;values select which baud rates.
mov dx,0                ;dx selects the port 0= COM1
INT 14H                 ;Call asynchronous services.
;
;done
```

Before the INT 14H is executed the registers that send data to the service are set.

Let us try a more elaborate example, one where the value returned by the service is relevant.

Example 2, Sending Data Out.

This uses service 1H to send a character to COM2. It examines the line status returned by the routine to see if the byte was sent correctly.

```
;Code fragment to send the byte held in
;location 'nextchar' COM2
;
mov ah,1                ;Send character, service 1H
mov al,nextchar         ;Set al to the value in nextchar
                        ;This value will be sent to COM2
mov dx,1                ;COM2
INT 14H                 ;Call asynchronous services.
;
;have attempted to send byte.
;If there is some problem service 1 will have
;timed out. It flags this by setting bit
;7 of the line status.
and ah,080H             ;This sets bits 0 to 6 of AH to 0.
jnz outproblem          ;If result is not zero (ie if bit 7
                        ;was set) jump to 'outproblem'.
;
jmp done                ;done
;
outproblem:
;code to deal with character not being sent here.
```

The values of the other bits in the line status recorded in AH are detailed in later chapters.

Let us now try an example using the new services provided by NewBIOS.

Example 3, Setting Port Addresses.

Service ADH sets the address of a port. Suppose that a second dual serial card has been added to the the machine giving COM3 and COM4. The BIOS must be told of its existence.

```
;Code fragment to set the addresses
;of COM3 and COM4.
;
mov ah, 0ADH            ;Set port address
mov dx, 2               ;COM3
mov bx,com3addr         ;address in i/o map of
                        ;chip for COM3
INT 14H                 ;asynchronous services.
cmp ax,052ADH           ;This number is the flag
                        ;returned by the service
                        ;to say that it is here.
jne biosproblem         ;If not set then NewBIOS
                        ;not installed
mov ah, 0ADH            ;Set port address
mov dx, 3               ;COM4
mov bx,com4addr         ;address of chip for COM4
INT 14H                 ;do it.
jmp done                ;done
;
;
biosproblem:
;code to deal with problem of NewBIOS not being present.
;E.g. print error message and halt.
```

Microsoft C And QuickC.

C is a powerful language with a wealth of facilities for both constructing high-level programs and controlling the machines on which they run. Microsoft C programs running on MS-DOS machines have a quite straightforward access to the machine's BIOS interrupts.

C provides several functions which access the machine interrupt routines. The most useful for NewBIOS is 'int86()', defined as:

```
int int86(int n, union REGS *inregs, union REGS *outregs);
```

where 'REGS' are

```
struct WORDREGS {
```

```
        unsigned int ax;
        unsigned int bx;
        unsigned int cx;
        unsigned int dx;
        unsigned int si;
        unsigned int di;
        unsigned int cflag;
        };

struct BYTEREGS {
        unsigned char al, ah;
        unsigned char bl, bh;
        unsigned char cl, ch;
        unsigned char dl, dh;
        };

union REGS {
        struct WORDREGS x;
        struct BYTEREGS h;
        };
```

Note how the union of WORDREGS and BYTEREGS reflects the actual organisation of the 8086 register set.

int86() places the values in 'inregs' in the registers of the 8086 and performs an INT n. On return the values in the 8086 registers are copied into 'outregs'. The value returned is that of the AX register. This means that the assembly language examples above are very easy to translate into C.

The reader not familiar with the interrupt routines may wish to read the section 'accessing asynchronous services' earlier in this chapter.

Example 1, Initialising A Port.

This example uses service 0H to set up the baud rate etc for COM1. Later chapter "NewBIOS Reference", contains details of this and all other BIOS services.

```
        /* C code fragment to set COM1 to 1200 baud*/
        /* even parity, seven data bits and 1 stop bit. */

        #include <bios.h>                /* Defines REGS and int86() */

        union REGS inregs, outregs;            /* Declare variables. */
        inregs.h.ah = 0x0;                 /* Service 0, initialise. */
```

```
inregs.h.al = 0x9A;                  /* Parameters as above. */
inregs.x.dx = 0x0;                                  /* COM1. */

int86(0x14, &inregs, &outregs);           /* Async services. */

/* Note:- that the return value
  and the value assigned to outregs are not used. */
/* Note:- also the address operator '&' used with inregs
  and outregs. */
```

The file BIOS.H includes a set of manifest constants for use with the standard asynchronous services. Using them makes the use of int86() slightly easier, so the above code would be:

```
inregs.h.ah = _COM_INIT;           /* Service 0, initialise. */
inregs.h.al = _COM_1200 +_COM_EVENPARITY +_COM_CHR7+_COM_STOP1;
                                                  /* Parameters */
inregs.x.dx = 0x0;                                     /* COM1. */

int86(0x14, &inregs, &outregs);    /* Asynchronous services. */
```

Example 2, Sending Data Out.

Service 1H is used to send char nextchar to COM2. This example examines the status returned by the service to check that the byte was sent correctly.

```
/* C code fragment to send a character to COM2. */

#include <bios.h>                /* Defines REGS and int86() */
union REGS inregs, outregs;            /* Declare variables. */
char nextchar;

inregs.h.ah = _COM_SEND;       /* Service 1, send character. */
inregs.h.al = nextchar;                /* character to send. */
inregs.x.dx = 0x1;                                  /* COM2. */

int86(0x14, &inregs, &outregs);            /* Async services */

if( outregs.h.ah & 0x80 )     /* Check that send successful. */
{
 printf("COM2 timed out on output.\n");
  exit(1);
};
```

Since the integer returned from the int86() procedure is the AX register we could use:

```
if( int86(0x14, &inregs, &outregs) & 0x8000 )
{
  printf("COM2 timed out on output.\n");
  exit(1);
};
```

Example 3, Setting Port Addresses.

Service ADH sets the address of a port. Suppose that a second dual serial card has been added to the machine giving COM3 and COM4 at addresses com3addr and com4addr. The BIOS must be informed of the location of the ports. The program also checks for the presence of NewBIOS.

```
/* C code fragment to set COM3 and COM4 addresses. */

#include <bios.h>                /* Defines REGS and int86() */
```

```
union REGS inregs, outregs;           /* Declare variables. */
unsigned com3addr, com4addr;

inregs.h.ah = 0xAD;            /* Service ADH, set address. */
inregs.x.dx = 0x2;                                 /* COM3. */
inregs.x.bx = com3addr;                 /* address of com3. */

int86(0x14, &inregs, &outregs);          /* Async services. */

if( outregs.h.ah != 0x52AD )  /* Check that send successful. */
{
  printf("NewBIOS not installed!\n");
  exit(1);
};

inregs.x.dx = 0x3;                                 /* COM 4. */
inregs.x.bx = com4addr;                 /* address of COM4. */

int86(0x14, &inregs, &outregs);
```

Borland Turbo Pascal.

This powerful and well-structured language has facilities to access the machine's BIOS in a quite straightforward way.

Turbo Pascal provides a procedure called Intr which access the machine interrupt routines. This is defined as:

```
PROCEDURE Intr(IntNo: Byte; VAR Regs: Registers);
```

where 'Registers' are

```
TYPE
  Registers =
      RECORD
        CASE Integer OF
          0: (AX,BX,CX,DX,BP,SI,DI,DS,ES,Flags: Word);
          1: (AL,AH,BL,BH,CL,CH,DL,DH: Byte);
      END;
```

Note how the record reflects reflects the actual organisation of the 8086, with its byte and word registers. The Procedure is part of the Dos unit.

Intr places the values in 'Regs' in the registers of the 8086 and performs an INT IntNo. On return the values in the 8086 registers are copied back into 'Regs'. This means that the assembly language examples above are very easy to translate into Turbo Pascal.

The reader may wish to read the earlier section of this chapter, 'accessing asynchronous services' which discusses the machine interrupts.

Example 1, Initialising A Port.

This example uses service 0H to initialise COM1. A later chapter, "NewBIOS Reference", contains details of this and all asynchronous services. The values that the service requires are loaded into Ioregs, and Intr is performed.

```
USES
  DOS; {Contains Registers type and Intr Procedure}
VAR
  Ioregs:   Registers;
BEGIN
  {Pascal code fragment to set COM1 to 1200 Baud,
   even parity, seven data bits and one stop bit.}
  WITH Ioregs DO BEGIN
    AH := $0;      {Service 0, initialise}
    AL := $9A;     {Parameters as above}
    DX := $0;      {COM1}

    Intr($14, Ioregs);  {Asynchronous services}
  END;
END.
```

Example 2, Sending Data Out.

This example uses service 1H to send Char nextchar to COM2. It examines the status returned by the service to check whether the character was sent correctly.

```
USES
  DOS;  {Contains Registers type and Intr Procedure}
VAR
  Ioregs:   Registers;
  NextChar: Char;
BEGIN
  {Pascal code fragment to send a char to COM2.}
  WITH Ioregs DO BEGIN
    NextChar := 'a';

    AH := $1;              {Service 1, send char}
    AL := Byte(NextChar);  {Character to send}
```

```
    DX := $1;              {COM2}

    Intr($14, Ioregs);  {Asynchronous services}

    IF
      ( AH AND $80 ) <> 0  {Check that send ok}
    THEN
      Writeln('COM2 timed out on output.');
  END;
END.
```

Example 3, Setting Port Addresses.

I/O addresses for COM3 and COM4 are set using service ADH. This is a service available only to NewBIOS. The program also checks for the presence of NewBIOS.

```
USES
  DOS;  {Contains Registers type and Intr Procedure}
VAR
  Ioregs:   Registers;
  Com3Addr,
  Com4Addr: Word;
BEGIN
  {Pascal code fragment to set}
  {COM3 and COM4 addresses.}
  WITH Ioregs DO BEGIN
    Com3Addr := $3220;
    Com4Addr := $3228;

    AH := $AD;      {Service ADH, set address}
    DX := $2;       {COM3}
    BX := Com3Addr; {Address of COM3}

    Intr($14, Ioregs);  {Asynchronous services}

    IF
      AX <> $52AD  {Check NewBIOS present}
    THEN BEGIN
      Writeln('NewBIOS not installed!');
      Halt(1);
      END;

    AH := $AD;      {Service ADH}
    DX := $3;       {COM4}
    BX := Com4Addr; {Address of COM4}
    Intr($14, Ioregs);
  END;
```

```
END.
```

QuickBASIC V4.5 & Visual Basic Dos.

QuickBASIC, and its highly compatible successor Visual Basic for Dos, are powerful structured languages which has managed to retain the easy program development of an interpreted BASIC. It can easily access the machine's BIOS.

QuickBASIC provides the 'Call Interrupt' subroutine to access the machine interrupt routines. This is declared as:

```
DECLARE SUB INTERRUPT (intnum AS INTEGER, inreg AS RegType,
                                          outreg AS RegType)
```

where 'RegType' is

```
TYPE RegType
      ax    AS INTEGER
      bx    AS INTEGER
      cx    AS INTEGER
      dx    AS INTEGER
      bp    AS INTEGER
      si    AS INTEGER
      di    AS INTEGER
      flags AS INTEGER
END TYPE
```

The subroutine is in the library 'QB.LIB', and the quick library 'QB.QLB'. Make sure that the latter is loaded into the QuickBASIC environment by adding the switch '/L' to the command line which invokes the environment, as

qb basterm /L

The two definitions above can be found in the include file 'QB.BI', which is used in the examples which follow.

Interrupt places the values in 'inreg' in the registers of the 8086 and performs an INT Intnum. On return the values in the 8086 registers are copied back into 'outreg'. This means that the assembly language examples above are very easy to translate into QuickBASIC.

The reader may wish to refer to the section earlier in this chapter 'accessing asynchronous services'.

Example 1, initialising a port.

This example uses service 0H to set the Baud rate etc. for COM1. A later chapter, "NewBIOS Reference", contains details of this and all other asynchronous services.

```
'QuickBASIC code fragment to set COM1 to 1200 Baud,
'even parity, seven data bits and 1 stop bit

DEFINT A-Z              'All parameters integers
REM $INCLUDE: 'QB.BI'
DIM inregs AS RegType, outregs AS RegType

inregs.ax = &H9A        'Ie AH = 00H, AL = 9AH
                        '==>Service 0H, initialise
                        'Parameters as above
inregs.dx = &H0         'COM1

CALL INTERRUPT(&H14, inregs, outregs)
```

Note that the programmer does not have access to the byte registers, AL, BH etc, as in Assembly language, C or Pascal. Splitting word values into, and creating word values out of, byte registers is illustrated in the next two examples.

Example 2, Sending Data Out.

This example uses service 1H to send a character to COM2. It examines the status returned by the service to check that the character was sent correctly.

```
'QuickBASIC code fragment to send a character to COM2
DEFINT A-Z
REM $INCLUDE: 'QB.BI'
DIM inregs AS RegType, outregs AS RegType

nextchar$ = "a"
inregs.ax = CVI(nextchar$ + CHR$(&H1))
                  'AH = 1, ==>Service 1H, send char
                  'AL = ASC(nextchar$)
'Generally:
'WordReg = CVI(CHR$(low_byte)+chr$(high_byte))
inregs.dx = &H1   'COM2

CALL INTERRUPT(&H14, inregs, outregs) 'Asynchronous services
```

```
al = outregs.ax AND 255                                    'Get at AL
ah = ASC(RIGHT$(MKI$(outregs.ax), 1))                      'Get at AH

IF ah AND &H80 THEN
  PRINT "COM2 timed out on output"
  END
END IF
```

The function CVI is used to convert the individual byte values into word values, and MKI$ is used to get at byte values returned in words. The competent BASIC programmer may wish to use the faster arithmetic functions to perform byte/word conversions, although care must be taken building an unsigned value in a signed 16-bit word.

Example 3, Setting Port Addresses.

In this example service ADH is used to set addresses for COM3 and COM4. Service ADH is only available through NewBIOS. The program also checks for the presence of NewBIOS.

```
'QuickBASIC code fragment to set COM3 and COM4 addresses
DEFINT A-Z
REM $INCLUDE: 'QB.BI'
DIM inregs AS RegType, outregs AS RegType

com3addr = &H3220
com4addr = &H3228

inregs.ax = &HAD00      'AH = ADH, ==>set address
inregs.dx = &H2         'COM3
inregs.bx = com3addr    'Address

CALL INTERRUPT(&H14, inregs, outregs)
                                                   'Async services

IF outregs.ax <> &H52AD THEN
  PRINT "NewBIOS not installed!"
  END
END IF

inregs.dx = &H3         'COM4
inregs.bx = com4addr    'Address

CALL INTERRUPT(&H14, inregs, outregs)
```

```
                                                    'Async services
END
```

GW-BASIC/BASICA.

BASICA or GW-BASIC is a straightforward language which offers simple convenient program development and which carries a good number of powerful features. Although it is supplied with all IBM machines and clones BASIC does not include among those features a method of accessing the machine's BIOS. The GW-BASIC/BASICA programmer must therefore resort to a small machine code interface which can be CALLed with the relevant parameters.

The method shown here is one such solution. The subroutine below loads a small machine code routine into an integer array. The routine is CALLed with four integer parameters (there must be exactly four, and they must be integers) which contain the values for the AX, BX, CX and DX registers. These values are copied over, INT 14H is performed, and the returned register values are copied back into the parameters. BASIC relocates arrays as variables are created, so it is important the the parameter variables are first used before the call statement, otherwise the machine code routine will be relocated in memory as the call is executed. The call must be told the location of the routine, and if it is told an incorrect location the system will crash.

The reader may wish to refer to the section earlier in the chapter called 'accessing asynchronous services', which discusses the machine interrupts.

BIOS Interface Setup Routine.

```
5000 'BIOS interface setup
5010 :
5020 DIM ASM%(23)      'Array to hold data
5030 :
5040 :
5050 TOT# = 0          'Data check
5060 RESTORE 5230
5070 :
5080 FOR I = 0 TO 21
5090   READ S$, T$                  'read in data
```

```
5100   ASM%(I) = VAL("&H" + T$ + S$)
5110   TOT# = TOT# + ASM%(I)
5120 NEXT I
5130 :
5140 IF TOT# = -144845! THEN 5190
5150 PRINT "Bad machine code data, terminating."
5160 PRINT "Check data statements at line 5230-"
5170 END
5180 :
5190 RETURN
5200 :
5210 '8086 machine code. Moves values in operands
5215 'to chip registers, performs INT 14H, and
5220 'copies the registers back to the variables.
5230 DATA 55            : 'PUSH BP
5240 DATA 8B,EC         : 'MOV BP,SP
5250 DATA 8B,76,0C      : 'MOV SI,[BP]+0CH
5260 DATA 8B,04         : 'MOV AX,[SI]
5270 DATA 8B,76,0A      : 'MOV SI,[BP]+0AH
5280 DATA 8B,1C         : 'MOV BX,[SI]
5290 DATA 8B,76,08      : 'MOV SI,[BP]+8
5300 DATA 8B,0C         : 'MOV CX,[SI]
5310 DATA 8B,7E,06      : 'MOV DI,[BP]+6
5320 DATA 8B,15         : 'MOV DX,[DI]
5330 DATA CD,14         : 'INT 14h
5340 DATA 89,15         : 'MOV [DI],DX
5350 DATA 89,0C         : 'MOV [SI],CX
5360 DATA 8B,76,0A      : 'MOV SI,[BP]+0AH
5370 DATA 89,1C         : 'MOV [si]+8,BX
5380 DATA 8B,76,0C      : 'MOV SI,[BP]+0CH
5390 DATA 89,04         : 'MOV [si]+6,AX
5400 DATA 5D            : 'POP BP
5410 DATA CA,08,00      : 'RETF 8
5420 DATA 00
```

The subroutine performs a check on the data to ensure that it is correct. The text of these GW-BASIC examples is included with the Serial Solutions software in the file 'GWTEST.BAS'.

Example 1, Initialising A Port.

This example uses service 0H to set the Baud rate etc for COM1. A later chapter, "NewBIOS Reference", contains details of this and all asynchronous services.

```
1000 'GW-BASIC BIOS interface test program
1005 'GW-BASIC code fragment to set COM1 to
1010 '1200 Baud, even parity, 7 data bits
1015 'and 1 stop bit.
```

```
1020 :
1030 DEFINT A-Z          'Parameters are Integers
1040 :
1050 GOSUB 5000          'Set up machine code
1060 :
1080 AX = &H9A           'Service 0, initialise
1090                     'Parameters as above
1100 DX = &H0            'COM1
1110 BX = 0              'These variables must exist
1115 CX = 0              'before call even if not used
1120 DEF SEG
1130 ADDR = VARPTR(ASM%(0))
1140 CALL ADDR(AX,BX,CX,DX)   'Call interrupt
1150 :
1160 END
```

The build-up to the call in lines 1080 to 1130 is important. All the parameters must be created (lines 1080 to 1115), the segment must be set to that of BASIC (line 1120), and the address of the interface routine calculated (line 1130). This calculation should be repeated every time the call is made because the array ASM% may have been relocated in memory. Note, as for QuickBASIC, that we do not has access to the byte registers, and that the program must explicitly build word registers from, and decompose word registers into, byte values. This is shown in the next example.

Example 2, Sending Data Out.

This example uses service 1H to send a character to COM2. The status returned by the service is examined to check that the character was sent correctly.

```
2000 'GW-BASIC code fragment to send a character to COM2
2030 DEFINT A-Z
2040 :
2050 GOSUB 5000          'Set up machine code
2060 :
2070 NEXTCHAR$ = "a"
2080 AX = CVI(NEXTCHAR$+CHR$(&H1))
2085                     'Service 1H, send character
2090 'General form of byte to word conversion:
2095 'WORD = CVI(CHR$(lo_byte)+CHR$(hi_byte)
2100 DX = &H1            'COM2
2110 BX = 0              'Must always create these
```

```
2115 CX = 0
2120 DEF SEG
2130 ADDR = VARPTR(ASM%(0))
2140 CALL ADDR(AX,BX,CX,DX)   'Call interrupt
2150 :
2160 AL = AX AND 255          'Get at byte registers
2170 AH = ASC(RIGHT$(MKI$(AX),1))
2180 :
2190 IF AH AND &H80 THEN PRINT "COM2 timed out on output":END
2200 :
2210 END
```

Note the use of the functions CVI and MKI$ to build byte values into words and decompose word values into bytes. The competent BASIC programmer may wish to use faster arithmetic functions to do this conversion, but care should be taken when trying to build an unsigned value in a signed word.

Example 3, Setting Port Addresses.

This example uses service ADH to set the i/o addresses for COM3 and COM4, it also checks for the presence of NewBIOS. The service is only available through NewBIOS.

```
3000 'GW-BASIC code fragment to set addresses for COM3 and COM4
3020 :
3030 DEFINT A-Z         'Parameters are integers
3040 :
3050 GOSUB 5000         'Set up machine code
3060 :
3070 COM3ADDR = &H3220
3080 COM4ADDR = &H3228
3090 :
3100 AX = &HAD00        'Service ADH, set address
3110 BX = COM3ADDR      'New address
3120 CX = 0             'Must create
3130 DX = &H2           'COM3
3140 :
3150 DEF SEG
3160 ADDR = VARPTR(ASM%(0))
3170 CALL ADDR(AX,BX,CX,DX)   'Call interrupt
3180 :
3190 IF AX <> &H52AD THEN PRINT "NewBIOS not installed!" :END
3200 :
3300 AX = &HAD00
3400 BX = COM4ADDR
3410 DX = &H3                 'COM4
```

```
3420 :
3440 ADDR = VARPTR(ASM%(0))
3450 CALL ADDR(AX,BX,CX,DX)   'Second call
3460 :
3470 END
```

Microsoft FORTRAN77.

FORTRAN 77, was the very first high-level language and, much enhanced, is still a mainstay of much computing. Microsoft FORTRAN77 for IBM PCs unfortunately provides no services to access the machine BIOS. However it is not to difficult to interface any FORTRAN program to subroutines written in languages which do support the BIOS.

Serial Solutions includes one such subroutine, called INTRPT (files 'intrpt.asm' and 'intrpt.obj'), written in assembly language. It was written to be used with large model programs, though it can be used with medium model code as well. It was assembled with CodeView information. The required interface statement looks like:

```
      interface to subroutine intrpt ( intno, regs)
C     Define data structure that Intrpt uses.

      structure /regtype/
      union
        map
          integer*1 al,ah,bl,bh,cl,ch,dl,dh
        end map
        map
          integer*2 ax,bx,cx,dx,si,di,cflag
        end map
      end union
      end structure

      integer intno [far,reference]
      record /regtype/ regs [far,reference]
      end
```

Note how the record used reflects the actual organisation of the 8086, with its byte and word registers.

'Intno' is the interrupt number to be initiated- any integer type (integer*1, integer*2 or integer*4) can be used. Intrpt places the values in 'regs' in the registers of the 8086 and performs

INT Intno. On return the values in the 8086 registers are copied back into 'regs'. This means that the assembly language examples above are very easy to translate into FORTRAN77.

The reader may wish to read the section earlier in this chapter called 'accessing asynchronous services', which discusses the machine interrupts.

The user program must be linked with the file 'intrpt.obj' , as

```
link myprog intrpt;
```

or

```
fl myprog.for intrpt
```

In medium model programs the 'far' attributes tell FORTRAN that intrpt is a large model routine and so compiles large (ie segmented) addresses.

Example 1, Initialising A Port.

This example uses service 0H to set the Baud rate etc. for COM1. A later chapter, "NewBIOS Reference", contains details of this and all asynchronous services.

```
      record /regtype/ registers

C     Example 1, set COM1 to 1200 Baud, 7 Data bits, even parity
C     and 1 stop bit.

C     service 0, initialise
      registers.ah = 16#0
C     parameters as above
      registers.al = 16#9A
C     COM1
      registers.dx = 0

      call intrpt (16#14, registers)
```

Example 2, Sending Data Out.

In this example service 1H is used to send character nextch to COM2. The example examines the values returned by the service to check that the character has been sent correctly.

```
      record /regtype/ registers
      character nextch /'a'/

C     Example 2, Send nextch to COM1

C     service 1, send character
      registers.ah = 16#1
C     character to send
      registers.al = ichar(nextch)
C     COM2
      registers.dx = 1

      call intrpt (16#14, registers )

      if( (registers.ah .AND. 16#80) .NE. 0 )then
            write (*,*) 'COM2 timed out on output.'
            stop
      end if
```

Example 3, Setting Port Addresses.

This example uses service ADH to set the i/o addresses of COM3 and COM4, it also checks for the presence of NewBIOS. This service is only available through NewBIOS.

```
      record /regtype/ registers
      integer*2 com3addr/16#3220/, com4addr/16#3228/

C     Example 3,set COM3 and COM4 addresses

C     service AD, set port
      registers.ah = 16#AD
C     i/o address
      registers.bx = com3addr
C     COM3
      registers.dx = 2

      call intrpt (16#14, registers )

      if( registers.ax .NE. 16#52ad )then
            write (*,*) 'NewBIOS not installed!'
```

```
            stop
        end if

C       Go again for COM4
        registers.ah = 16#AD
        registers.bx = com4addr
        registers.dx = 3

        call intrpt (16#14, registers )
```

NewBIOS Default Settings.

When NewBIOS is installed the addresses and IRQ lines associated with each port are as shown in below.

Figure 4-1 NewBIOS Defaults.

Port	I/O Address	IRQ Line
COM1	As ROM BIOS (see note 1)	4 (see note 3)
COM2	As ROM BIOS	3
COM3	As ROM BIOS	3
COM4	As ROM BIOS	3
COM5	0 (see note 2)	3
COM6	0	3
COM7	0	3
COM8	0	3
COM9	0	-1 (see note 4)
COM10	0	-1
COM11	0	-1
COM12	0	-1
COM13	0	-1
COM14	0	-1
COM15	0	-1
COM16	0	-1

Notes:

1) The ROM BIOS services maintain a list of addresses for COM1 to COM4 (at address 0040:0000), which NewBIOS copies into its own lists when it is installed. Changes to COM1 to COM4 affected via NewBIOS are also written to the ROM BIOS list of addresses.

2) A zero value indicates that no serial chip is known to be present for that COM port.
3) COM1 to COM8 are assumed to have the IRQ line defined by IBM for those ports.
4) An IRQ line of -1 (or 255 since these are stored as byte values), indicates that no IRQ line has been allocated to the port.

IBM's technical references for PS/2 machines includes a list of preferred addresses and IRQ lines for COM1 to COM8. These are:

Port	Address	IRQ
COM1	03F8	4
COM2	02F8	3
COM3	3220	3
COM4	3228	3
COM5	4220	3
COM6	4228	3
COM7	5220	3
COM8	5228	3

In standard PC compatibles, using ISA. AT, VESA local bus and PCI interfaces COM3 and COM4 are usually set as follows:-

Port	Address	IRQ
COM3	03E8	3 (or 4)
COM4	02E8	3

The Power On Self Test (POST), a ROM program which is run whenever the machine is rebooted, checks the preferred addresses of COM1 and COM2 to see if there is a serial chip present. If a chip is present it writes its address to the list of ports that the ROM BIOS uses. NewBIOS reads this list, and so in turn will recognise COM1 and COM2 at their default addresses without any interference.
Most PC's since 1990/92 also automatically detect the presence of COM3 and COM4 adding them to the BIOS data table. These too are then recognised by NewBIOS.

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Chapter 5

NewBIOS Reference.

Introduction.

This Chapter lists all the services provided by NewBIOS in order of service number. For each service the following are noted: its compatibility with the ROM BIOS, parameters, return values, meaning and other points.

Where a service differs from an IBM equivalent the Serial Solutions version is described, and the differences to the IBM version noted.

The explanations supplied refer to the 16450, the serial communications chip used in PC compatibles. The 16450 is a higher specification version of the older 8250. Most modern 486 and Pentiums use the 16550 chip, this is an enhanced 16450 chip. Serial Solutions automatically detects and uses the enhanced features of the 16550 serial port chip when it is present in the PC.

Many BIOS services do little more than read from and write to the 16450, so the reader may wish to refer to the National Semi-conductor data sheet for the chip or to a serial communications text which covers the 16450/16550 series.

Using The Services.

The services all switch to an internal stack when called, so only require eight bytes of user stack space, including the six bytes used by INT 14H and IRET.

All registers are preserved across the call, except those which it is explicitly stated are used to return values after the call. Only the registers AX, BX, CX, and DX, are used to communicate with the calls, so it can be assumed that BP, DI, SI, the segment registers and the flags will not be affected by calling NewBIOS.

DX Register Value.

The DX register is used to specify which serial port is being used. If DX=0 then COM1 is being used, if DX=3 then COM4 is being used. The maximum value allowed for DX depends on which version of NewCOM.SYS has been loaded in the CONFIG.SYS file. The versions of NewCOM.SYS have been supplied on the disks:-
NewCOM.SYS supports up to COM16, max DX value = 15.
NewCOM24.SYS supports up to COM24, max DX value = 23.
NewCOM32.SYS supports up to COM32, max DX value = 31.

Error Returns.

The services will not return an explicit error code if any of the supplied parameters is incorrect- for example a port that has not been set up. For most such errors the service will terminate harmlessly, though this is not guaranteed, and a bad parameter may cause unexpected side-effects. The transmit and receive character services return the status of the transmit/receive attempt, that is time-outs and receiver errors, if they have been called with correct parameters. These return codes have been detailed with the services.

Figure 5-1. NewBIOS Functions Summary.

Service.	Built In BIOS Function.
0H	Initialise communications port.
1H	Send character.
2H	Receive character.
3H	Read status.
4H	Extended initialise.
5H	Extended communications port control.

Service.	NewBIOS Function Provided by Serial Solutions.
ADH	Set port address.
AEH	Get number of ports.
AFH	Get/Set IRQ line.
B0H	Get/Set Hardware Handshake.
B1H	Get/Set Software Handshake.
B2H	Get/Set Card Type.
B3H	Get/Control Buffers.
B4H	Get Serial Solution Capability.

Summary Of Services.

The asynchronous services available are:

Service 0H, initialise communications port.

This sets the port parameters. These are the baud rate, parity, number of stop bits and word length.

Service 1H, send character.

Send a single (usually ascii) character to the port.

Service 2H, receive character.

Receive a single character from the port.

Service 3H, read status.

The state of the RS232 handshake input lines and the status of the serial chip (including things like reception errors, chip ready to send data) are returned. The other standard services return some or all of this information anyway.

Service 4H, extended initialise.

Provided on the PS/2 ROM BIOS (and on NewBIOS for all PCs), this performs a similar function to service 0H, but allows a wider range of parameters to reflect the full capabilities of the serial chip and is somewhat easier to use. The NewBIOS version extends the ranges of baud rates available still further.

Service 5H, extended communications port control.

This allows us to read, via subservice 0, the state of the RS232 handshake output lines, and to to set them via subservice 1.

NewBIOS adds the following completely new services.

Service ADH, set port address.

Serial chips at the standard addresses defined by IBM for COM1 and COM2 are automatically recognised by the ROM BIOS (and hence NewBIOS) when the machine is powered on or reset, but NewBIOS must be told of the existence of chips at other addresses. This service returns the address previously attributed to the port. It also returns particular values as flags, so that this service can be used to check for the presence of NewBIOS. The program 'NewBIOS.com' uses this method to decide whether or not to install NewBIOS.

Service AEH, Get number of ports.

The number of ports set up (ie with valid addresses) is returned.

Service AFH, Get/Set IRQ line.

This service exists to support NewCOM, which can use interrupts for more convenient and efficient serial input/output. Subservice 0 returns the IRQ line which a particular com port is assumed to be using, and subservice 1 sets this. Ports COM1 to COM8 are given default values (which may need to be altered), but ports COM9 onwards must be explicitly set before NewCOM can use them in interrupt mode.

Service B0H, Get/Set Hardware Handshake.

This service exists to support NewCOM, which can use several different hardware handshakes. The hardware handshake is the way that the control lines associated with a serial port are used. The input lines (CTS, DSR, DCD and RI) are checked to ensure that it is ok to send data out, and the output lines (RTS and DTR) are set to say whether the driver has space to read any more data. The handshake selected by this service defines which lines are used, and how. This service also returns a flag to show whether the driver, NewCOM, is present, as opposed to NewBIOS alone.

Service B1H, Get/Set Software Handshake.

This service exists to support NewCOM, which can use software handshakes. A software handshake uses special characters, conventionally called XON and XOFF, to control the flow of data. This is to be compared with a hardware handshake, where control lines fulfil the same purpose. Subservices 0 and 1 allow software handshaking to be turned on and off, and subservices 2 and 3 allow the actual characters to be used as the flow control characters, XON and XOFF, to be changed.

Service B2H, Get/Set Card Type.

This service exists to support NewCOM, which can use non-standard serial cards. The inherent limitation of the serial ports on a standard IBM PC or clone is the number of ports that can use buffered i/o. Many cards are therefore manufactured which circumvent this limitation. These require special treatment, and this service tells the device driver that the port specified is on a special card, and supplies any relevant additional information.

Service B3H, Get/Control Buffers.

This service exists to support NewCOM, which can use buffered i/o for more convenient and efficient serial input/output. Subservices 0 and 1 read the status of the buffers associated with a port. Subservices 2 and 3 flush the buffers. Subservices 4,5,6 and 7 can disable/enable the buffers for a port.

Service B4H, Get Serial Solution Capability.

This service reports the version of Serial Solutions being used and the maximum number of serial ports supported.

Service 0H, Initialise.

Compatibility.

This Service is fully compatible with the PC ROM BIOS.

Parameters.

AH	=	00H	Denotes service 0H
AL	bits	7,6,5	Specify Baud rate as
	=	0,0,0	110
	=	0,0,1	150
	=	0,1,0	300
	=	0,1,1	600
	=	1,0,0	1,200
	=	1,0,1	2,400
	=	1,1,0	4,800
	=	1,1,1	9,600
AL	bits	4,3	Denote parity
	=	0,0	None
	=	0,1	Odd
	=	1,0	None
	=	1,1	Even
AL	bit	2	Denotes number stop bits
	=	0	1 stop bit
	=	1	2 stop bits (1.5 stop bits if 5 bit word)
AL	bits	1,0	Denote number data bits
	=	0,0	5 data bits
	=	0,1	6 data bits
	=	1,0	7 data bits
	=	1,1	8 data bits
DX	=	0..31	Port number, 0=COM1...31=COM32

Return Values.

AH	is		16450 Line status, where
	bit 7	=	0, always
	bit 6	=	Transmitter shift register empty
	bit 5	=	Transmitter holding register empty
	bit 4	=	Break interrupt
	bit 3	=	Framing error
	bit 2	=	Parity error
	bit 1	=	Overrun error
	bit 0	=	Data ready
AL	is		16450 modem status, where
	bit 7	=	DCD, Data Carrier Detect
	bit 6	=	RI, Ring Indicator
	bit 5	=	DSR, Data Set Ready
	bit 4	=	CTS, Clear To Send
	bit 3	=	Delta DCD, set true if bit 7 has changed since last read
	bit 2	=	Delta RI " " " " 6 " " " " "
	bit 1	=	Delta DSR " " " " 5 " " " " "
	bit 0	=	Delta CTS " " " " 4 " " " " "

These return values for AL, AH are the same as for services 3H, 4H and 5H (they are generated by the same piece of code).

Meaning.

Service 0H, initialise, sets the parameters in AL for the serial port specified by DX. Bits 7, 6, 5 are used to generate a baud rate divisor for the 16450. These bits are then set to zero and the byte is written to the 16450 line control register.

The line status and modem status registers are read and returned by the AH and AL registers respectively. Bits 6, 5, 0 of the line status reflect whether data can be moved in or out of the 16450, and bits 4, 3, 2, 1 denote various error conditions on the receive line. The modem status records the state of the various input lines apart from received data (Rx) on the RS232 port.

Other Points.

IBM documentation does not mention the 5- and 6-bit word length settings on the 16450, but these are faithfully written to the 16450 by this service, in both its IBM and Serial Solutions form, as above.

IBM documentation treats the return values of services 0H to 5H as the same, listing values which are an amalgam of the correct ones for various services. This listing is more faithful to the IBM routines and the Serial Solutions routines.

Service 1H, Send Character.

Compatibility.

This Service is fully compatible with the PC ROM BIOS.

Parameters.

AH	=	1H	Denotes service 1H
AL	=	byte	Character to send
DX	=	0...31	Port number, 0=COM1...31=COM32

Return Values.

AH	is	16450 Line status or time-out, where
bit 7	=	Time-out. If true then remaining bits are undefined
bit 6	=	Transmitter shift register empty
bit 5	=	Transmitter holding register empty
bit 4	=	Break interrupt
bit 3	=	Framing error
bit 2	=	Parity error
bit 1	=	Overrun error
bit 0	=	Data ready
AL	is	preserved

Meaning.

Service 1H, send char, sends the character specified in AL to the port specified in DX. The service performs a handshake by asserting the RS232 output lines RTS and DTR, then waits for the CTS and DSR lines to go true. If they do not the routine fails with a time-out error. If they do go true then the service waits again for the transmitter buffer empty (TBE) bit in the 16450 to go true, and if it does not fails with a time-out error. If TBE goes, or is already, true the character to send is written to the 16450's transmitter buffer and the service returns.

The time-out period, after which a time-out error is returned, is fixed by a software loop. This time period will therefore vary from machine to machine. For example in the original 4.77MHz 8088 PC it is about 1.3 seconds, and on a 20MHz 80286 AT it is about 0.43 seconds.

Other Points.

The character specified in AL is written unchanged to the 16450, which automatically truncates it to the correct length (5, 6, 7 or 8 bits) and adds the correct parity bit if parity has been set. The user need not worry about these.

RTS and DTR are left asserted, and as a side effect loop, out1 and out2 (the other bits in the modem control register) are left reset. This is important because PC serial cards use out2 to gate interrupts off and on. Resetting out2 prevents interrupts from the 16450 reaching the PC slot. This is fine for the BIOS routines which do not use interrupts, but NewCOM, BASIC and any sensible serial communications software, do. Use of this BIOS service alongside these is therefore not recommended.

Service 2H, Receive Character.

Compatibility.

This Service is fully compatible with the PC ROM BIOS.

Parameters.

AH	=	2H	Denotes service 2H
DX	=	0...31	Port number 0=COM1...31=COM32

Return Values.

AH	is	16450 Line status or time_out, where
bit 7	=	Time-out. If true then remaining bits are undefined
bit 6	=	0
bit 5	=	0
bit 4	=	Break interrupt
bit 3	=	Framing error
bit 2	=	Parity error
bit 1	=	Overrun error
bit 0	=	0
AL	is	Character received.

Meaning.

Service 2H waits for a character to arrive from the serial port. As service 1H it first performs an RS232 handshake by setting DTR and clearing RTS, and waits for DSR to go true. A time-out is returned if it does not. The service then waits for the 16450 to receive a character, and either returns it or a time-out. The line status returned in AH can be used to check for receiver errors such as a parity error.

Other Points.

The same timing loop is used as for service 1H.

RTS and DTR are left asserted, and as a side effect loop, out1 and out2 (the other bits in the modem control register) are left reset. This is important because IBM-style serial cards (ie almost all) use out2 to gate interrupts off and on. Resetting out2 prevents interrupts from the 16450 reaching the host processor bus. This is fine for the BIOS routines which do not use interrupts, but NewCOM, BASIC and any sensible serial communications software, do. Use of this BIOS service alongside these is therefore not recommended.

Service 3H, Read Status.

Compatibility.

This Service is fully compatible with the PC ROM BIOS.

Parameters.

AH	=	03H	Denotes service 3H
DX	=	0...31	Port number, 0=COM1...31=COM32

Return Values.

AH	is		16450 Line status, where
	bit 7	=	0, always
	bit 6	=	Transmitter shift register empty
	bit 5	=	Transmitter holding register empty
	bit 4	=	Break interrupt
	bit 3	=	Framing error
	bit 2	=	Parity error
	bit 1	=	Overrun error
	bit 0	=	Data ready
AL	is		16450 modem status, where
	bit 7	=	DCD, Data Carrier Detect
	bit 6	=	RI, Ring Indicator
	bit 5	=	DSR, Data Set Ready
	bit 4	=	CTS, Clear To Send
	bit 3	=	Delta DCD, set true if bit 7 has changed since last read
	bit 2	=	Delta RI " " " " 6 " " " " "
	bit 1	=	Delta DSR " " " " 5 " " " " "
	bit 0	=	Delta CTS " " " " 4 " " " " "

These return values for AL, AH are the same as for services 0H, 4H and 5H (they are generated by the same piece of code).

Meaning.

Service 3H simply reads the line status and modem status registers of the 16450.

Other Points.

This service may prove useful to save a program from waiting for the send or receive service to time-out. The user can check the handshake and the receive/transmit buffers using service 3H- if the port is not ready the user program can do something useful while it waits for the port to get ready. When ready use service 1H and/or 2H, knowing that they will return immediately.

Service 4H, Extended Initialise.

Compatibility.

This service was first used in the ROM BIOS of IBM PS/2 machines and is supported by most modern PCs. The NewBIOS version is fully compatible with the version documented in the PS/2 BIOS technical reference, but allows a wider range of baud rates.

Parameters.

AH	=	04H	Denotes service 4H
AL	is		Break control, where
	=	0	no break
	=	1	break
BH	is		Parity, where
	=	00H	None
	=	01H	Odd
	=	02H	Even
	=	03H	Mark (Stick parity odd)
	=	04H	Space (Stick parity even)
BL	is		Stop bits, where
	=	00H	One
	=	01H	Two (One and a half for 5-bit word length)
CH	is		Word length, where
	=	00H	5 bits
	=	01H	6 bits
	=	02H	7 bits
	=	03H	8 bits
CL	is		Baud rate, where
	=	00H	110 Baud
	=	01H	150 Baud
	=	02H	300 Baud

	=	03H	600 Baud
	=	04H	1,200 Baud
	=	05H	2,400 Baud
	=	06H	4,800 Baud
	=	07H	9,600 Baud
	=	08H	19,200 Baud
	=	09H	38,400 Baud (NewBIOS only)
	=	0AH	57,600 Baud (NewBIOS only)
	=	0BH	115,200 Baud (NewBIOS only)
DX	=	0...31	Port number, 0=COM1...31=COM32

Return Values.

AH	is		16450 Line status, where
	bit 7	=	0, always
	bit 6	=	Transmitter shift register empty
	bit 5	=	Transmitter holding register empty
	bit 4	=	Break interrupt
	bit 3	=	Framing error
	bit 2	=	Parity error
	bit 1	=	Overrun error
	bit 0	=	Data ready
AL	is		16450 modem status, where
	bit 7	=	DCD, Data Carrier Detect
	bit 6	=	RI, Ring Indicator
	bit 5	=	DSR, Data Set Ready
	bit 4	=	CTS, Clear To Send
	bit 3	=	Delta DCD, set true if bit 7 has changed since last read
	bit 2	=	Delta RI " " " " 6 " " " " "
	bit 1	=	Delta DSR " " " " 5 " " " " "
	bit 0	=	Delta CTS " " " " 4 " " " " "

These return values for AL, AH are the same as for services 0H, 3H and 5H (they are generated by the same piece of code).

Meaning.

Service 4H is an extended initialise, providing more functions than its sibling, service 0H. It is also easier to use since it is not necessary for the programmer to build the complex parameter byte written to the 16450, the service builds it.

The baud rate parameter in CL is used to index a table of divisors, one of which is written to the 16450 baud rate divisor latch. The remaining parameters are translated into a byte which is written to the 16450 line control register.

The 16450 line and modem status are returned.

Other Points.

The Baud rates available via the Serial Solutions service are to be used with care as the higher ones will only work under the most favourable conditions on a direct line and on a fast machine.

Service 5H, Extended Control.

Compatibility.

This service was first used in the ROM BIOS of IBM PS/2 machines and is supported by most modern PCs. The NewBIOS version is fully compatible with the version documented in the PS/2 BIOS technical reference.

Parameters.

AH	=	05H	Denotes service 5H
DX	=	0...31	Port number, 0=COM1...31=COM32
AL	=	00H	Denotes Read modem control register
AL	=	01H	Denotes Write modem control reg:-
	BL	is	Modem control register
	bits	7,6,5	Reserved
	bit 4	=	Loop
	bit 3	=	Out2
	bit 2	=	Out1
	bit 1	=	Request To Send (RTS)
	bit 0	=	Data Terminal Ready(DTR)

Return Values.

AH	is		16450 Line status, where
	bit 7	=	0, always
	bit 6	=	Transmitter shift register empty
	bit 5	=	Transmitter holding register empty
	bit 4	=	Break interrupt
	bit 3	=	Framing error
	bit 2	=	Parity error
	bit 1	=	Overrun error
	bit 0	=	Data ready
AL	is		16450 Modem status, where
	bit 7	=	DCD, Data Carrier Detect

bit 6	=	RI, Ring Indicator
bit 5	=	DSR, Data Set Ready
bit 4	=	CTS, Clear To Send
bit 3	=	Delta DCD, set true if bit 7 has changed since last read
bit 2	=	Delta RI " " " " 6 " " " " "
bit 1	=	Delta DSR " " " " 5 " " " " "
bit 0	=	Delta CTS " " " " 4 " " " " "

These return values for AL, AH are the same as for services 0H, 3H and 4H (they are generated by the same piece of code).

BL	is	Modem control register, as above.

Meaning.

Service 5H allows the user to read and set the output lines from the 16450 and the loop function. Subservice 0, where AL is 0, reads the modem control register back into BL. Subservice 1, where AL is 1, writes the value in BL into the modem control register.

Other Points.

From the point of view of the 16450 the four output lines are identical, but serial cards usually use them as follows.

Bit	Use
DTR	Becomes the DTR signal on the RS232 interface
RTS	Becomes the RTS signal on the RS232 interface
Out1	Not used
Out2	When set TRUE gates interrupts from the 16450 ON.

The last line, out2, is worth examining in greater detail. When the out2 bit is set true logic on IBM’s serial card allows the

interrupt signal from the 16450 to reach the system bus and interrupt the host microprocessor. When the out2 bit is false the interrupt line is disconnected from the system bus. To maintain full PC compatibility all serial cards perform this gating function on out2, and newer serial chips such as the 16552 include within themselves the logic to do this, so that out2 does not appear outside the chip.

Outputs from the 16450 use negative logic, that is setting a bit true in the chip causes the relevant output line to go false. This can be largely ignored from the software's point of view, because the serial card will re-invert the lines when converting them to the +/- 12 volt levels required by RS232 or the +/- 5 volt differential lines of RS422 and RS485.

Service ADH, Set Port Address.

Compatibility.

NewBIOS service only, ignored by PC ROM BIOS.

Parameters.

AH	=	ADH	Denotes service ADH
DX	=	0...31	Port Number 0=COM1...31=COM32
BX	=		Port address

Return Values.

AX	=	52ADH Flag for presence of NewBIOS
BX	=	Old port address

Meaning.

Service ADH informs NewBIOS of the I/O addresses of the ports installed in the machine. The value in BX is swapped with that in NewBIOS' list of addresses. For COM1 to COM4 the list maintained by the ROM BIOS is also updated.

The AX register is set to the value 52ADH as a flag that NewBIOS has been installed. The ROM BIOS services will not report an error if the user attempts to use their non-existent service ADH, so applications which require NewBIOS should check this at least once.

Other Points.

A port with an address of 0 is regarded as 'unset' or 'not present'.

It is best to set the port addresses using the /A command on the NewCOM.SYS line in the CONFIG.SYS file.

This service, along with service AFH, should perhaps be best used via a program executed by the autoexec.bat file when the machine is booted. This leaves the serial ports correctly set

up when the machine is used, and minimises the (ugly) risk of beginning to use a port and then altering it's address.

The reader who is not well acquainted with the architecture of the 8086 series processors may be a little confused by references to I/O addresses. Under the 8086 architecture all I/O devices are accessed by a bus (logically) separate to that which accesses memory, although there is strictly nothing to prevent I/O devices being placed on the memory bus (video memory can in fact be considered in this category), or even memory being placed on the I/O bus. The I/O bus uses a 16-bit address to select which I/O device to access. An 16450 serial chip occupies seven contiguous I/O addresses, and the first of these is what is meant by 'the I/O address of the chip'. The value of the address is defined by the wiring of the serial card which holds the chip, and can usually be swapped between several different values via switches on the card, or by software for a Micro Channel Architecture card or Plug and Play cards.

The same I/O address can be given to more than one serial port, as no checking is performed.

Service AEH, Get Number Ports.

Compatibility.

NewBIOS service only, ignored by PC ROM BIOS.

Parameters.

AH	=	AEH	Denotes service AEH

Return Values.

AX	=	Number ports set up.

Meaning.

Service AEH returns the number of ports that have been set up. It reads through the list of addresses and counts those that are set (that is are non-zero).

Other Points.

If the ports are allocated sequentially (ie for ’n’ ports set COM1 to COMn are set and COMn+1 onwards are unset), the number returned by this service can be used to filter references to unset ports- these are ports beyond COMn.

Service AFH, Get/Set IRQ Line.

Compatibility.

NewBIOS service only, ignored by PC ROM BIOS.

Parameters.

AH	=	AFH	Denotes service AFH
DX	=	0...31	Port number, 0=COM1...31=COM32
AL	=	00H	Denotes read IRQ line
AL	=	01H	Denotes write IRQ line, and
BL	=	2..15	IRQ line 2..15 (-1 means no line)

Return Values.

BL	=	2..15	IRQ line used (-1 means no line)

Meaning.

Service AFH is used to read or set the IRQ line used with a particular port. NewBIOS does not use these values but the NewCOM.SYS device driver does use them. On a read the value of the IRQ line for the port is returned in BL, and on a write the value in BL is used to set the IRQ line used with the port.

It is best to set the IRQ line on the NewCOM.SYS line in the CONFIG.SYS file using the /I command for stand alone serial ports and the /L command for interrupt sharing multiports cards.

Other Points.

NewBIOS allows the setting of IRQ lines for ports whose address has not yet been set, but their address remains zero and they cannot be used. An IRQ line value of -1, = 255, means 'no IRQ set', and forces NewCOM to use polled I/O for that port.

Figure 5-2. Interrupt Allocation.

IRQ	NORMAL USE	COMMENTS	STATUS
2	VGA GRAPHICS CARD	Used by very few VGA cards	Usually OK
3	COM2	Dedicated to COM2 at 2F8hex	COM 2 ONLY
4	COM1	Dedicated to COM1 at 3F8hex	COM 1 ONLY
5	LPT 2	DOS/WIN don't use this IRQ Avoid with OS/2 Novell WinNT	Good in DOS & Windows
6	FLOPPY DISK	Dedicated to Floppy Disk	AVOID !!!
7	LPT 1 Soundblaster	DOS/WIN don't use this IRQ Avoid with OS/2 Novell WinNT	Good in DOS & Windows
10	Usually Free	Recommended for COM3	GOOD
11	Usually Free Adaptec SCSI	Recommended for COM4 if not Adaptec SCSI card	GOOD
12	POINTING DEVICE	Free if Mouse is on COM port	Usually OK
14	IDE HARD DISK	Usually In Use. Free when SCSI disks in use	Usually BAD
15	Usually Free	Recommended	GOOD
0	Timer Tick, 18 per second, not on expansion bus		CAN'T USE
1	Keyboard interrupt, is not on expansion bus		CAN'T USE
8	Real Time clock interrupt, not on expansion bus		CAN'T USE
9	Best left unexplained, is not on expansion bus		CAN'T USE
13	Maths coprocessor int, not on the expansion bus		CAN'T USE

Each serial port needs its own interrupt line for trouble free performance, if two serial ports are allocated the same IRQ line only one can use it at any time. NewCOM allows one port to use the IRQ line, and any others allocated that line are polled. For DOS and Windows 3.x use, after COM1 and COM2 installed, then IRQs 5, 7, 10, 11, 12 and 15 are available.

Service B0H, Get/Set Hardware Handshake.

Compatibility.

NewBIOS service only, ignored by PC ROM BIOS.

Parameters.

AH	=	B0H	Denotes service B0H
DX	=	0...31	Port number, 0=COM1...31=COM32
AL	=	00H	Denotes read hardware handshake mode
AL	=	01H	Denotes set hardware handshake mode, where
BL	=	0..4	Mode, as 0 ==> standard RS232 RTS/DTR 1 ==> RS422 RTS/CTS handshake 2 ==> RS485 half duplex 3 ==> RS485 send only 4 ==> No handshake used, Txd, Rxd and Gnd only.

Return Values.

AX	=	53ACH if device driver present, 0H if NewBIOS is present but NewCOM is not.
BL	=	Hardware handshake mode

Meaning.

Service B0H is used to read or set the hardware handshake mode used with a particular port. NewBIOS itself does not use these values, but the NewCOM.SYS device driver does. On a read the value of the mode for the port is returned in BL, and on a write the value in BL is used to set the mode used with the port.

The following modes are currently supported:

Mode	Use
0	RS232 standard, DTR/CTS (this was the default)
1	RS422 RTS/CTS
2	RS485 half duplex handshake, RTS set true during output.
3	RS485 send only, RTS always set true.
4	No handshake, also known as three handshake. Only Txd, Rxd and Ground wires need be connected. All other lines are ignored. (This is now the default)

Chapter "What To Do First", section "Handshake Selection" gives more details of the hardware handshakes.

Other Points.

NewBIOS will allow the setting of handshake modes for ports whose address has not yet been set, but their address remains zero and they cannot be used.

Service B1H, Get/Set Software Handshake.

Compatibility.

NewBIOS service only, ignored by PC ROM BIOS.

Parameters.

AH	=	B0H	Denotes service B0H
DX	=	0...31	Port number, 0=COM1...31=COM32
AL	=	00H	Denotes read software handshake mode
AL	=	01H	Denotes set software handshake mode, where
BL	=	0..1	Mode, as 0 ==> software handshake disabled 1 ==> software handshake enabled
AL	=	02H	Denotes read XON and XOFF characters
AL	=	03H	Denotes write XON and XOFF characters, where
BL	=	0-255	current XON character
BL	=	0-255	current XOFF character

Return Values.

Subservices 00H and 01H, read/set software handshake:

BL	=	Software handshake mode as above

Subservices 02H and 03H, read/set XON and XOFF:

BL	=	XON character
BH	=	XOFF character

Meaning.

Service B1H is used to read or set the software handshake mode used with a particular port, and to select the characters that are to be used as XON and XOFF. NewBIOS itself does not use these values, but the NewCOM.SYS device driver does. On reading the handshake mode the value of the mode for the port is returned in BL, and on a write the value in BL is used to set the mode used with the port. On reading the XON and XOFF characters the values of the characters are returned in BL and BH respectively, and on a write BL and BH are used to set the characters.

The default is to have software handshaking disabled, and to use ascii character 17 (DC1) as XON and ascii 19 (DC3) as XOFF.

Chapter "What To Do First", section "Handshake Selection" gives more details of the software handshake.

Other Points.

NewBIOS will allow the setting of handshake modes for ports whose address has not yet been set, but their address remains zero and they cannot be used.

Service B2H, Get/Set Card type.

Compatibility.

NewBIOS service only, ignored by PC ROM BIOS.

Parameters.

AH	=	B2H	Denotes service B2H
DX	=	0...31	Port number, 0=COM1...31=COM32
AL	=	00H	Denotes read card type
AL	=	01H	Denotes set card type
BL	=	0..2	type, as 0 ==> standard serial port (on card or on motherboard). This is the default. 1 ==> Brain Boxes Lynx or Quad port serial card, also DigiBOARD PC/4 or PC/8 2 ==> Flynix-8 FAT-011.
AL	=	02H	Denotes read card dependent information, where
BX, CX	=		Up to 4 bytes information
AL	=	03H	Denotes set card dependent information, where
BX, CX	=		Up to 4 bytes information

Return Values.

Subservices 00H and 01H, read/set card type:

BL	=	Card type as above

Subservices 02H and 03H, read/set card dependent

information:

BX, CX	=	Up to 4 bytes information

Meaning.

Service B2H is used to read or set the type of card that this serial port occupies, and to read/set the extra information required to use some cards. NewBIOS itself does not use these values, but the NewCOM.SYS device driver does. On reading the card type the value of the type for the port is returned in BL, and on a write the value in BL is used to set the type. On reading the card information BX and CX return the required information, and on a write BX and CX are used to set the information.

There are three card types currently supported:

Standard IBM- type 0.

This is the usual serial port supplied on the mother board or addon cards in a PC. This card requires no other information.

Brain Boxes Lynx and Quad cards and compatibles- type 1.

This card allows all eight ports to use the same interrupt line via special interrupt sharing hardware. The extra information required is as follows:

BX	=	Address of card status register. Set by DIP switches on the card.
CL	=	Port number, 0 for port 1 on the card, 1 for port 2 etc.
CH	=	Interrupt line use by the card.

The interrupt set via (or assumed by) NewBIOS service 0AFH is ignored by the device driver for Brain Boxes Lynx and Quad port cards as the interrupt specified here is used instead.

This service is used to set up each port on the card that will use interrupt sharing (ports on the card can be switched from the interrupt sharing hardware to a standard interrupt line). For each call the address of the status register will be the same, but the port number will be different. NewCOM needs to know

the port number on the card so that it can identify the source of any interrupt- port 1 is not assumed to be COM1 and so on.

Type 1 compatible cards:

DigiBOARD PC/4 and PC/8.

These use similar interrupt sharing hardware to the Brain Boxes Lynx and Quad cards, but each card has two status registers and two interrupt lines. However the second status register is usually ignored on the Digiboard card. When one one interrupt and status register is being used set the card up as a Brain Boxes Lynx card.
For the two status register setup: The installation guide gives an address for the status register for the odd-numbered interrupt, and the address of the status register for the even-numbered interrupt line is one greater than this.

Set up a DigiCHANNEL card as two Brain Boxes cards, with status registers at adjacent addresses, the first used with the odd-numbered interrupt line and the second with the even-numbered interrupt line.

Flynix-8 FAT-011 and compatibles- type 2.

This has eight ports arranged in two groups of 4, each group having a status register and interrupt line associated with it. The information associated with a Flynix card is as follows:

BX = Address group status register-read only.
CL = Port number, 0 for port 1 on the card, 1 for port 2 etc.
CH = IRQ line- writable only for the last port of a group, otherwise read only.

The irq line and status register address are the same for all ports in a group. The status register address is calculated from the i/o address of the last port in a group (port 4 or port 8) by NewBIOS, so is a read-only field, any value written will be ignored. Setting the IRQ for the last port in a group sets the IRQ for the remaining ports in a group, and can only be read from those ports. NewCOM needs to know the port number on

the card so that it can identify the source of any interrupt- port 1 is not assumed to be COM1 and so on.

The interrupt set via (or assumed by) NewBIOS service 0AFH is ignored by the device driver for Flynix-8 cards as the interrupt specified here is used instead.

This service is used to set up each port on the card that will use interrupt sharing (ports on the card can be switched from the interrupt sharing hardware to a standard interrupt line).

Other Points.

NewBIOS will allow the setting of card types and dependent information for ports whose address has not yet been set, but their address remains zero and they cannot be used.

Service B3H, Get/Control buffers.

Compatibility.

NewBIOS service only, ignored by PC ROM BIOS.

Note The EASYC.C program contains sample C source code to write directly into the buffers and demonstrates the use of kickstart.

Parameters.

AH	=	B3H	Denotes service B3H
DX	=	0...31	Port number, 0=COM1...31=COM32
AL	=	00H	Denotes read status input buffer
AL	=	01H	Denotes read status output buffer
AL	=	02H	Denotes flush input buffer
AL	=	03H	Denotes flush output buffer
AL	=	04H	Denotes disable input buffer
AL	=	05H	Denotes disable output buffer
AL	=	06H	Denotes enable input buffer
AL	=	07H	Denotes enable output buffer
AL	=	08H	Denotes get input buffer addresses
AL	=	09H	Denotes get output buffer addresses

Return Values.

Subservices 00H read input buffer status:

AH = buffer disabled flag, true if buffer disabled and false if buffer enabled

BX	=	number of bytes in buffer
CX	=	size of buffer in bytes

Subservice 01H, read output buffer status:

AH	=	buffer disabled flag, true if buffer disabled and false if buffer enabled
AL	=	false if output handshake false, we cannot transmit true if output handshake true, we can transmit.
BX	=	number of bytes in buffer
CX	=	size of buffer in bytes

Subservices 02H to 07H, flush, disable and enable buffers, have no return values.

Subservices 08H get input buffer address:

AX	=	Segment Address of the buffer.
BX	=	Address of Pointer to buffer TAIL.
CX	=	Address of Pointer to buffer HEAD.
DX	=	Length of the buffer -1. This is called BLENMASK
DS	=	Data Segment containing TAIL and HEAD pointers.

Subservices 09H get output buffer address:

AX	=	Segment Address of the buffer.
BX	=	Address of Pointer to buffer TAIL.
CX	=	Address of Pointer to buffer HEAD.
DX	=	Length of the buffer -1. This is called BLENMASK
DS	=	Data Segment containing TAIL and HEAD pointers.
DI	=	Offset Of Kickstart Routine to retrigger o/p after updating buffers. Segment in DS (same as tail & head ptrs) Note make a FAR call to this routine.

Meaning.

Service B3H is used to read the status of the buffers associated with a port, and to control those buffers. NewBIOS itself does not use these values but the NewCOM.SYS device driver does.

The buffer status of a port which has been opened by NewCOM but for polled rather than buffered i/o is reported by subservices 00H and 01H as a port with 1-byte input and output buffers, the chip registers. This is to allow software to be able to make the same tests of the 'buffers', whether or not they are real. There are however some differences. Because the output register is beyond the control of NewCOM, the contents of this 'output buffer' will still be sent if the output handshake goes false. Then, even though there appears to be a byte free in the output buffer, writes to it will be blocked. These 'buffers' cannot be flushed or halted.

Port which have not been opened are reported as having halted buffers which are zero bytes long.

The disable buffer functions simply prevent data from moving between the buffer and the serial chip by disabling the interrupt responsible for that. Reads and writes to the port can still be performed. Bytes coming in to the port will be lost if the input buffer is disabled. By default both buffers are enabled.

Manipulating buffer contents using subservices 08h & 09h.

```
mov ah,0B3h
mov al,08h                    ;get input buffer addresses
int 14h
mov es,ax                     ;buffer is in this segment
mov di,ds:[bx]
            ;save the contents of the tail ptr here for later
;
;calculate amount of data in the buffer
mov ax,ds:[cx]          ;get the contents of the head ptr
mov bx,ds:[bx]           ;get the contents of the tail ptr
sub ax,bx                     ;take tail away from head
```

```
        and ax,dx          ;ensure that is within range mask with
                                                    BLENMASK

        mov cx,ax                                   ;put count here
        mov bx,offset USERSDATABUFFER
                                                    ;YOU DECIDE WHERE!

show05: mov al,es:[di]          ;get from Serial Solution Buffer
        mov cs:[bx],al                              ;save
        inc di
        inc bx
        and di,dx          ;validate the address with blenmask
        loop show05
        ;
        ;NOTE since we have not changed the Serial
        Solution pointers we have just made a copy of the
        data in the Serial Solution buffer
```

Other Points.

NewBIOS ignores calls to ports whose address is zero. If the device driver has not been installed, that is if NewBIOS has been installed alone, then the buffer status is returned as for a closed port, a halted, zero-byte long buffer.

Note The EASYC.C program contains sample C source code to write directly into the buffers and demonstrates the use of kickstart.

Service B4H, Get Serial Solution Capability

Compatibility.

NewBIOS service only, ignored by PC ROM BIOS.

Parameters.

AH = B4H Denotes service B4H

Return Values.

AX = 52ADH Flag for presence of NewBIOS

BX = Version Of Serial Solutions eg 2.95
BH = Major Version Number eg 2
BL = Minor Version Number eg 95 (range 0-99)

DX = Max Number Of Devices Supported -1
newcom.sys =15 COM1-COM16
newcom24.sys =23 COM1-COM24
newcom32.sys =31 COM1-COM32

Meaning.

Service B4H informs NewBIOS/NewMODE of the current version number of Serial Solutions and of now many serial port devices it supports.

Chapter 6

Terminal Emulators.

Introduction.

Two sets of sample programs are included with Software Solutions. These are the EASY programs and the TERM programs.

The 'EASY' programs EASYC, EASYBAS and EASYPAS should be every users first stop when encountering Serial Solutions. They are short, easy to understand and they work well. By opening a file to the COMn device and performing standard file read and write commands data is sent and received from the serial port out to the external devices.
Use and learn from the Easy programs FIRST!

The TERM programs are a set of terminal emulation programs written in C (Cterm), Assembly language (Aterm), Pascal (Pasterm), BASIC (BASterm) and FORTRAN (FORterm). Their main purpose is to demonstrate serial port programming in a variety of languages, and are also useful tools for using serial devices. They are long, involved but they cover virtually every call to NewBIOS. Tackle them only after you have discovered something you cannot do using the EASY programs.

All the TERM programs were written to behave in exactly the same way, (except for the get and put commands, only present in Cterm), so the use of the programs is covered once in this chapter. Subsequent chapters discuss the way that the individual programs work.

Using Terminal Programs.

Setting up.

The terminal programs are designed to be used with NewCOM, the interrupt-driven serial port device driver. The device driver handles all the more difficult parts of serial communications, such as handshaking and buffering. It must have been installed in the machine by placing the line

c>**device = newcom.sys**

in the config.sys file of the machine. See earlier chapters for more details of the installation process.

NewCOM will recognise all serial ports correctly in the CONFIG.SYS file.

Running Terminal Programs.

Once the driver has booted the user can execute the terminal using the command

c>**<name> <definition_file>**

where <definition_file> is the optional name of a text file containing commands for the program to read when it starts, and <name> is 'Cterm', 'Pasterm', 'Aterm', 'BASterm' or 'FORterm'. The file 'BASTERM.EXE' on the distribution disk was compiled under QuickBASIC 4.5, but the source can be run under Visual Basic for DOS, QBASIC, GW-BASIC or BASICA. The chapter on BASterm provides more information. The file of commands defines the way that the terminal will work, and are detailed later in this section. If there is no file specified on the command line, or the specified file cannot be found, then Terminal looks for a file called 'TERMDEF.TXT', and if it finds it treats it as a definition file. A sample TERMDEF.TXT is included on the distribution disk.

Once the terminal is running any characters typed at the keyboard are sent to the serial port, and any characters received from the serial port are displayed on the screen. At any time the user can hit a function key, which have the following effects:

F1 Display a help screen

F2 Setup. This is a group of menus which interactively set up

the serial port. At each menu the user must hit one of the digit keys to make a selection. The menus include setting the port, the Baud rate, the number of data bits, the number of stop bits and the parity.

F10 Quit. This immediately exits the program.

ALT-C

(That is 'C' and the 'ALT' key pressed together). CTERM prompts the user for a command. The user can enter a command together with any parameters that it requires. These are the same commands found in the definition files, and control the way that the terminal functions.

Commands.

The commands which can be included in a definition file or typed at the keyboard consist of a single letter (whose case is ignored) followed by an optional list of parameters. Only one command is allowed per line, and generally spaces can be inserted freely between parameters. In the following table characters enclosed in angled braces <thus> indicate a symbol which should be replaced with a string defined later. Optional parameters are enclosed in square braces [to indicate that they don't necessarily have the included]. Alternatives are enclosed in curly braces and separated by vertical bars as {one|or another|but not both}.

H Displays help information. Has same effect as hitting F1 in CTERM.

Q Exits program. Same Effect hitting F10 in CTERM.

E <echo>[<echo>] where <echo>={n|l|s}

Echo. The letters specify either no echo (n), echo to screen (s) and/or echo to line (l). Echo to screen means that characters typed at the keyboard are displayed on the screen as well as sent to the serial port. Echo to line means that characters received from the serial port are sent out to it. Do not set this latter option if connected to a device which also does this, as the two devices will

continually echo back and forth the first character transmitted! Eg

E ls sets both line and screen echo.

C <port_name>

Set the serial port (or other device) to use. Eg

C COM3 sets terminal to COM3.

B <baud>

where <baud>={110| 150| 300| 600| 2400| 4800| 9600| 19200| 38400| 57600| 115200}

Set Baud rate. The Baud rates can be abbreviated to two digits (3 for 115200 Baud). Eg

B 1200 sets 1200 Baud

P{n|o|e|m|s}

Set parity. n = none, o = odd, e = even, m = mark and s = space.

D {5|6|7|8}

Set number data bits.

S {1|2}

Set number stop bits. If the number of data bits is 5, then 2 stop bits are interpreted as 1 1/2 stop bits by the serial hardware.

I <char>:<strn>

where <char> = a decimal number or character in quotation marks

<strn> = a sequence of decimal numbers and characters in quotation marks, separated by commas

Set an input translation. Whenever the character <char> is read from the serial port it is replaced by the characters in <strn>. <strn> can be empty. The translation is applied after any echo to line has been performed. Eg

I 13:10,'--' translates a carriage return into a line feed followed by two minus signs. See the later section on using translations.

O <char>:<strn>

where <char> and <strn> are as above.

Set an output translation. The character <char> is replaced by the characters in <strn>. <strn> can be empty. The translation is applied after any echo to screen has been performed. Eg

O 10:13,10 translates a line feed into a carriage return and line feed. See later section on using translations.

X <filename>

Execute. The file <filename> is read and its contents executed. This file may itself contain further X commands, up to the limit DOS and the language impose on open files. Eg

X termdef.txt is the equivalent of the action Terminal takes when it is started with no command line parameters.

R <command...>

Run the DOS command <command...>. Eg

R newmode com1:300,n,8 could be used as an alternative to the B, P and S commands which set the same parameters.

T <strn> defined as above.

Transmit the characters of <strn> over the serial line. The usual output translations are not applied.

Note that when Terminal starts it does not open the serial port until it either executes a C command to set the port, or it finishes executing the definition file. This means that a T command in a definition file before any C commands will fail.

’ <comment>

Comment line. The contents of <comment> are sent to the screen, and no other action is taken.

U <filename>[n][<char>]

Put file to serial port. This is available in Cterm only. See chapter 7, Cterm, for more details.

G <filename>[n][<char>]

Get file from serial port, This is available in Cterm only. See chapter 7, Cterm, for more details.

Example.

The following commands are included on the distribution disk as 'TERMDEF.TXT'.

'Terminal Definitions for CTERM etc.

This is a comment. It has no other function

c com1

This tells the terminal to use COM1. Any valid device name could be used.

e s

This sets echo to screen only. Characters typed at the keyboard are sent to the screen before being translated and sent to the serial port.

b 1200

This sets the Baud rate at 1200 Baud.

p e

This sets even parity.

d 7

This sets the word length to 7 bits.

s 1

This sets the number of stop bits to 1.

o 10:13,10

This forces the terminal to send a line feed as a carriage return and a line feed.

i 13:10

This forces the terminal to convert any carriage returns received to line feeds.

Using Translations.

Translations offer the user a way of smoothing over the differences between different pieces of equipment. The usual horrors are to do with the end of line characters carriage return and line feed. No two systems ever seem to quite agree over these. Internally Terminal uses the line feed character alone to

mark the end of a line, so whatever serves as an end of line marker for the remote device must be translated on input to a line feed. (This is the convention for C/UNIX programs). TERMDEF.TXT above was written to work with a terminal which sent a lone carriage return. To handle a device which sent a carriage return and a line feed Terminal could either be left alone (it would perform a carriage return operation at the carriage return, and do a new line operation on the line feed, and the spare carriage return would have no effect), or could be set to ignore carriage returns with the command

i 13:

On output Terminal must translate the line feed into whatever the remote device requires. TERMDEF.TXT above uses a carriage return and line feed.

The translation facility could be used more creatively, for example to display the control characters received.

i 0:'(NULL)'
i 7:'(BEL'
i 27:'(ESC)'
etc.

Or to assign a meaningful text string to a key, eg

o 24:13,'LOGOFF',13

(character 24 is CTRL-X)

Chapter 7

Cterm.

Introduction.

C is a powerful language which is gaining popularity because of its comprehensive libraries and the economy of the run-time code developed. The serial ports provided by NewCOM can be easily programmed in C, and this chapter describes how.

CTERM is a terminal emulator originally written in Microsoft C. (It was developed under QuickC version 2.0, and the distributed version compiled using the C 5.1 optimising compiler.) It is primarily a teaching aid for NewCOM and C, but is in its own right a powerful tool for working with serial devices.

This chapter contains two main sections. The first and most important section discusses the way that CTERM uses the serial port. The second section takes a less detailed look at the organisation of the whole of CTERM.

Running Cterm.

Run Cterm with the command:

c>**Cterm <defn_file>**

Where <defn_file> is an optional file of commands for Cterm to execute- described in detail in an earlier chapter. These commands define the way that the terminal will operate.

Once the terminal is running any characters typed at the keyboard are sent to the serial port, and any characters received from the serial port are displayed on the screen. At any time the user can hit a function key, which have the following effects:

F1 Display a help screen

F2 Setup. This is a group of menus which interactively set up the serial port. At each menu the user must hit one of the digit keys to make a selection. The menus include setting the

port, the Baud rate, the number of data bits, the number of stop bits and the parity.

F10 Quit. This immediately exits the program.

ALT-C (That is 'C' and the 'ALT' key pressed together). CTERM prompts the user for a command. The user can enter a command together with any parameters that it requires. These are the same commands found in the definition files, and control the way that the terminal functions.

Translations.

Cterm has the ability to translate any characters read from the serial port or the keyboard to a sequence of zero, one or more characters. See the chapter "Terminal Emulators" for more detail. Note the following though. When Cterm translates characters received form the serial port it uses a null character (value 0) to mark the end of the sequence. This means that a null cannot be included as part of an input translation. Since null cannot be displayed this does not greatly matter for general use, but when sending and receiving files with translations nulls will disappear. If this is a problem do not use translations. Nulls can be included in output translations and can be transmitted with the T command.

Get And Put Files.

Cterm contains two extra commands for complete file transfers. These are the 'g' (for 'get') and 'u' (for 'put') commands. Both have the same operands:

<filename>[n][<char>]

<filename> is the name of the file to be read or written. It can contain a full drive and path specification, but if it does not the default drive and directory are assumed.

n is an optional switch which disables translations during the transfer. The n can be either in upper or lower case.

<char> is an optional character, specified as a decimal integer or as a character in quotation marks, which is used as an end of file character. Do not use an end of file character if the data to be transferred is binary rather than text, because it could contain

the same byte as the end of file character as a legitimate piece of data.

On put, the specified file is sent to the serial port. Unless the 'n' switch is used the file is translated in exactly the same way that characters typed at the keyboard are. The end of file character, possibly after a translation, is sent to the serial port. The transfer can be halted by pressing a key at any stage.

On get, the serial port is read and the characters received are written to the file specified. If the 'n' switch is present the characters are not translated on input. If an end of file character is present the transfer continues until that character is read, otherwise a five second timeout is used. The end of file character is not carried over to the file. The transfer can be halted by pressing a key at any stage.

Examples:

g file1.txt 26

Read data into file1.txt until character 26, CTRL-Z, is received.

u file2.exe n

Send file2.exe, do not translate, and add no termination characters.

g file3.tmp n

Read file3.tmp, do not translate, stop if no data arrives for five seconds.

The CTERM Serial Connection.

This section will look at the parts of CTERM that access the serial port and so explain how any C program could use the serial port with NewCOM. The use of the serial port is quite straight- forward, as NewCOM does most of the hard work.

Quick Summary.

To send and receive characters to an from a serial port in C use the following functions.

```
FILE *com;                          /* Create a file variable */
.
```

```
com = fopen("COM1","rb");          /* Open file for input, or */
com = fopen("COM1","wb");              /* open for output, or */
com = fopen("COM1","rb+");                 /* open for both.  */
.
c = getc( com );                            /* read from file */
fputc( com );                               /* Write to file  */
.
fseek( com, 0l, SEEK_SET);            /* Flush C output buffer */
i = ferror( com );       /* Check for errors on transmission */
.
fclose( com );                         /* Close file to tidy up */
```

Cterm accesses the BIOS services provided by NewCOM with the C function int86(), in the Cterm function Bios_x_init(). This allows Cterm to set serial port parameters such as Baud rate and parity.

Cterm also uses a DOS function to change the way that DOS handles files, from cooked mode to raw data mode, which prevents DOS from interfering with control characters. This is encapsulated in the function Uncook().

The low-level i/o functions of Microsoft C, open, close, read and write, could be used instead of the stream i/o functions above.

Opening The File.

In CTERM the function ’open_com()’, Figure 7-1, opens the file associated with the serial port.

Figure 7-1. Function open_com().

```
FILE *com_inp,    *com_out;
                                        /* Files for: com port input */
                                                  /* com port output */
char comname[] = "COM1\0   ";                                 /* Name */

/* Open com port. */
void open_com(void)
{
      char bf[80];                          /* Temporary text buffer. */

      com_inp = fopen(comname,"rb");              /* Open port input */
      if( com_inp == NULL )
      {
            sprintf(bf, "Failed to open %s\nTry different params.\n"
                                                            ,comname);
            screen(bf, fromctrl);
      }
      else
            uncook(com_inp);               /* Set to raw data mode. */
            rewind( com_inp );

      com_out = fopen(comname,"wb");            /* Open port output */
      if( com_out == NULL )
      {
            sprintf(bf, "Failed to open %s\nTry different params.\n"
                                                            ,comname);
            screen(bf, fromctrl);
            fclose(com_inp);
      }
      else
            uncook(com_out);               /* Set to raw data mode. */
            rewind( com_inp );
}
```

Open_com() shows the two file variables (com_inp for input and com_out for output) that refer to the serial port. A single file could be used but this introduces the risk of losing characters as the file buffer maintained by C is flushed between reads and writes. The fopen() function creates a file structure for the com port that these variables refer to. It takes two operands, the name of the file and a string showing how the file will be used. In this latter string the character ’r’ means ’read’, ’w’ means ’write’, and ’b’ means that the file is a binary file. The last parameter prevents C from translating end of file and end of line characters. We set this so that we can accurately control the

characters sent to and received from the serial port. If the open fails (comname may have been set to a non-valid device with the C command in CTERM) then fopen returns a value NULL. Open_com tests this and generates an error message if the value is NULL.

At this stage the device driver has not been accessed. The fopen statement has allowed C and DOS to prepare for I/O to the port, setting up their variables and buffers.

MS-DOS as well as C can alter characters as they are sent and received. We can alter the mode that DOS assigns to the file from the default (called 'cooked', where translations are performed) to a more direct one (called 'raw'). The raw mode has the advantage that data transfers are performed on as many bytes as possible at a time, rather than one byte at a time, as cooked mode does. The change from cooked to raw mode is performed by the function uncook(), shown in Figure 7-2.

Figure 7-2. Function uncook().

```
/* Alter mode of file from cooked (DOS default) to raw. */
/* Prevents translation of CR/LF, trapping of CTRL-Z and */
/* Allows read/write operations to be performed more efficiently. */
void uncook(FILE *file)
{
      union REGS inregs, outregs;

            /* Change IOCTL from Cooked to RAW data function 0x44. */
            inregs.h.ah = 0x44;
            inregs.h.al = 0x00;                  /* get device data */
            inregs.x.bx = fileno(file);
            intdos( &inregs, &outregs );
            inregs.x.dx=outregs.x.dx;
            inregs.h.dl=inregs.h.dl | 0x20;   /* set raw data mode */
            inregs.h.dh=0;
            inregs.h.al = 0x01;                  /* set device data */
            intdos( &inregs, &outregs );
}
```

Uncook() uses DOS service 0x44 to read alter, and set the device data that DOS maintains. It uses the C function fileno() to find the handle (a short integer) that DOS associates with the file.

Reading From The File.

The function inpstr(), below, reads from the serial port.

Figure 7-3. Function inpstr().

```
/* Read a character from com port. */
/* If echo to line true then send it back out. */
/* Return value is number of bytes read.       */
int inpstr(char *data)
{
      int c;

      c = getc( com_inp );
      *data = char( c );

      if( c == EOF )
      {
            clearerr( com_inp);
            return 0;   /* EOF is error condition ==> return none. */
      }
      else
      {
            if( echo & echol )  /* If echo set then send back out. */
                  outstr(data, 1);
            return 1;
      };
}
```

The read is performed by getc(). It is at the first access of the port for a read or write that the driver itself is actually accessed. It sets up its internal buffers, which are essential for interrupt driven I/O, and initialises the serial hardware. If the driver can return no data then getc() returns the value EOF (end of file), which inpstr() checks. Inpstr() also handles echo to line, by calling outstr(), the serial output function.

Writing To The File.

Writes to the serial port are performed by outstr() below.

Figure 7-4. Function outstr().

```
/* Send a string of characters to com port. */
/* This routine must deal with write errors on COM port. */
void outstr(char *data, int count)
{
      int i,c;
      time_t t1, t2;

      for(i = 0; i < count ; i++)
      {
            time( &t1 );
            fputc(*(data + i), com_out);
            fseek(com_out, 0l, SEEK_SET); /* Reset file pointer..means
                                                          flush */
            while( ferror(com_out)
                  && (difftime(time(&t2),t1) < timeout) )
            {
                  clearerr(com_out);
                  fputc(*(data + i), com_out);
                  fseek(com_out, 0l, SEEK_SET);         /* Reset file
                                          pointer..means flush */
            };
            if( ferror(com_out) )
            {
                  screen("Failed to output to port.\n",fromctrl);
                                                /* Write failure */
                  clearerr(com_out);
            };
      };
}
```

The output function in C used is fputc(). The ferror function is used to detect any problems with writing the character. The problem may be a full output buffer at the driver level. Outstr handles this by trying to send each byte until the error condition ends. If after a time interval set by the variable timeout the error persists outstr gives up and prints an error message. The other terminal programs do not perform these retrys- they are present here to support the put command, which relies on outstr sending all the bytes given to it to the file.

Closing The File.

The C function fclose() is used to close the file. It does not access the device driver, but merely informs DOS and C that the program no longer wishes to use the file. The files are closed by:

```
fclose(com_inp);
fclose(com_out);
```

performed just before the program ends or during a change of port on the 'C' command in CTERM.

Serial Port Parameters.

The serial port has several settings, the Baud rate, parity etc., which must be set to the values that the remote device requires. The commands in CTERM which do this all call one function, called bios_x_init(), which can set all these parameters.

Figure 7-5. Function bios_x_init().

```
/* Use BIOS services to set port parameters. */
/* Assumes presence of NewBIOS. */
/* Returns a flag to indicate whether it has succeeded. */
int bios_x_init(int port, int brk, char par,
                                        int stop, int data, long baud)
{
      union REGS inregs, outregs;

      if( port < 1 || port > 16 )
            return FALSE;               /* Bad port specification. */
      else
            inregs.x.dx = port - 1;               /* port number. */

      inregs.h.al = (char)(brk ? 1 : 0);       /* Break parameter. */

      switch( tolower(par) )
      {
            case 'n': inregs.h.bh = 0;              /* Parity none */
                                        break;
            case 'o': inregs.h.bh = 1;               /* Parity odd */
                                        break;
            case 'e': inregs.h.bh = 2;              /* Parity even */
                                        break;
            case 'm': inregs.h.bh = 3;              /* Parity mark */
                                        break;
```

```
        case 's': inregs.h.bh = 4;              /* Parity space */
                                        break;
        default:  return FALSE;   /* Bad parity specification. */
    };

    if( stop < 1 || stop > 2 )
        return FALSE;           /* Bad stop bits specification. */
    else
    inregs.h.bl = (char)(stop-1);

    if( data < 5 || data > 8 )
        return FALSE;            /* Bad databits specification. */
    else
        inregs.h.ch = (char)(data - 5);

    if(
            ( inregs.h.cl = (char)prefer_baud(&baud) ) == -1
        )
        return FALSE;                           /* Bad Baud rate. */

    inregs.h.ah = 0x04;       /* Service 4, extended initialise. */
    int86(0x14, &inregs, &outregs);           /* Async services. */

    return TRUE;                                          /* Done */
}
```

Bios_x_init() uses the extended initialise service supplied as part of NewBIOS to set the port up. It works its way though the function parameters, checking that each has a valid value and translating them into values that the BIOS will understand. The chapter "NewBIOS Reference", sets out the parameters that service 4, the extended initialise, requires. The parameters are store in the REGS variable inregs, which is used to specify the parameters to int86(). See the chapter "Using NewBIOS" for an explanation of the use of int86() in C.

The parameters taken by bios_x_init() are:

Port	Numbers 1..16 for COM1 to COM16 respectively
Brk	Break, if non-zero then set serial output line to space.
Par	Parity, a single character, one of 'n', 'o', 'e', 'm' or 's' for none, odd, even, mark or space.
Stop	Number stop bits. 1 or 2, though if 5 data bits

are selected the serial hardware interprets 2 stop bits as 1 1/2 bits.

Data — Number of data bits. 5, 6, 7 or 8.

Baud — Baud rate. The CTERM function prefer_baud() is used to check and translate this.

Bios_x_init returns a true flag to show that is has checked its parameters, found them to be ok, and used them to set the serial port. If the parameters are bad then a false flag is returned and the serial port is left alone.

Fitting The Parts Together.

The main() function of CTERM is shown in below.

Figure 7-6. Function main.

```
void main(int argc, char **argv)
{
      init_screen();                              /* Set up screen. */
      init_xlat();               /* initialise translation tables. */
                                  /* This may need to be replaced. */

      exec_defaults(argv);  /* Find and execute a file of commands */

      open_com();                                 /* Open com files. */

      while( TRUE )                             /* Main program loop. */
      {
            readin();              /* get any characters from port. */
                                                 /* send to display. */

            switchout();             /* Read and process characters */
                                                  /* from keyboard. */
      };
}
```

Init_screen() and init_xlat() set up internal variables for use by CTERM. Exec_defaults checks for a command line parameter and attempts to execute the file of commands to which it refers. If it cannot find the file, or if no file is specified on the command line then the file 'TERMDEF.TXT' is tried. Open_com opens the serial port, as discussed in the previous section. The program then enters an infinite loop which alternately calls two functions, switchout() and readin().

Readin() checks for characters at the serial port, calling the function inxlat() (that is input and translate), which in turn calls inpstr(), discussed in the previous section. If inxlat() returns a non-nul string of characters the readin() prints them out.

Switchout() polls the keyboard using kbdinp(). A character, if entered, is compared with zero. A zero byte indicates an extended character code, used for the function, cursor and edit keys and ALT key combinations. These are all taken to be commands, and so the function menuout() is called to deal with them. All other keys are echoed (if echo to screen has been set), and then passed on to outxlat(). Outxlat() translates the characters and uses outstr() to send them on to the serial port. Outstr() is examined in the section above.

Menuout() deals with the function keys and the ALT-C key. It reads the second byte of the extended key code and interprets it as a request to perform a certain action, and calls cmdout() for help, quit and commands, and setup() for the setup option. Cmdout() decodes a character string as a command (whether the string is from the keyboard, a file or a literal in the program does not matter), calling one of the command execution routines to do the actual work. Setup() present the user with a group of menus to allow set up the serial port. It gets options from the user and calls the command execution routines to perform them.

Note the use of the function screen() throughout for output to the screen. This function at this time simply calls printf(), but is used so that future versions of CTERM can easily use separate windows or a marking scheme to separate the three type of text that appear on the screen- characters from the serial port ('fromport'), echoed characters from the keyboard ('fromecho'), and control information from the program ('fromctrl'). The second parameter of screen() flags this. Figure 7-7 contains examples of this.

Figure 7-7. Screen Output Examples.

```
if( echo & echos )        /* May need to echo character to screen. */
screen(c,fromecho);
inxlat(bf);                              /* Read in some characters. */
if(*bf != '\0' )                              /* If some read in ok. */
screen(bf,fromport);
screen("Command not recognised\n",fromctrl);
screen("Command not recognised\n",fromctrl);
```

The actual commands which access the serial port are comparatively simple to use, and are almost hidden by the remainder of Cterm. The user should not find any great difficulty in using serial port from C.

Chapter 8

Aterm

Introduction.

The serial ports provided by NewCOM can be easily accessed from Assembly language, and this, combined with assembly language's advantages of speed, compact code and good machine control, make it a good choice for serial port programming.

ATERM is a version of the terminal emulator. Its main purpose is to demonstrate serial port programming in 8086 assembly language under MS-DOS, and was written for MASM (Microsoft macro assembler) version 5.1. It will also prove to be a useful tool for using serial devices.

This chapter contains two main sections. The first and most important section discusses the way that ATERM uses the serial port. The second section takes a less detailed look at the organisation of the whole of ATERM.

Running ATERM.

Once the driver and port have been set up the user can execute ATERM using the command

c>**aterm <definition_file>**

where <definition_file> is the optional name of a text file containing commands for ATERM to read when it starts. These define the way that ATERM will work, and are detailed in the earlier chapter "Terminal Emulators".

Once the terminal is running any characters typed at the keyboard are sent to the serial port, and any characters received from the serial port are displayed on the screen. At any time the user can hit a function key, which have the following effects:

F1 Display a help screen

F2 Setup. This is a group of menus which interactively set up the serial port. At each menu the user must hit one of the

digit keys to make a selection. The menus include setting the port, the Baud rate, the number of data bits, the number of stop bits and the parity.

F10 Quit. This immediately exits the program.

ALT-C (That is 'C' and the 'ALT' key pressed together). Aterm prompts the user for a command. The user can enter a command together with any parameters that it requires. These are the same commands found in the definition files, and control the way that the terminal functions.

Translations.

Aterm has the ability to translate any characters read from the serial port or the keyboard to a sequence of zero, one or more characters. The chapter "Terminal Emulators" discusses this in more detail. Note the following: When Aterm translates characters received form the serial port it uses a null character (value 0) to mark the end of the sequence. This means that a null cannot be included as part of an input translation. Since null cannot be displayed this does not greatly matter for general use. Nulls can be included in output translations and can be transmitted with the T command.

The ATERM Serial Connection.

This section will look at the parts of ATERM that access the serial port and so explain how any assembly language program could use the serial port with NewCOM. The use of the serial port is quite straight forward, as NewCOM does most of the hard work.

Quick Summary.

From assembly language use DOS functions through INT 21H to access the serial port. The functions used by Aterm are as follows.

Function 3DH, open handle, to open a file to the serial port;
Function 3FH, read handle, to read characters from the port,

Function 40H, write handle, to send characters to the port and
Function 3EH, close handle, to close the file.

BIOS services provided by NewBIOS are accessed through INT 14H, in the subroutine bios_x_init, to set parameters such as the Baud rate and parity associated with a port.

DOS function 44H codes 0 and 1 are used to get and set respectively the device data maintained by DOS. This allows the subroutine uncook to change the file associated with the serial port from cooked to raw data mode. The latter allows more than one character at a time to be transmitted, and prevents DOS interfering with control characters.

Opening The File.

In ATERM the subroutine 'open_com' opens the port.

Figure 8-1. Subroutine Open-com.

```
;*********************************************************************
;*                                                                   *
;*  open_com- attempts to open file comname. Stores file handle      *
;*          in comport. If fails prints a message to that effect.    *
;*                                                                   *
;*********************************************************************
;
; On entry
;   Segment registers as start proc
;   Other regs undefined
;
; On exit
;   AX undefined
;   BX undefined
;   DX undefined
;
;   Flags undefined
;   All other regs unaffected.
;   Stack useage-as DOS functions 3DH, procs uncook, screen
;
open_com proc near
      mov ah,3DH                                    ;DOS open handle
      mov al,2            ;Access code ==> no inherit, compatibility
                                  ;sharing and read/write access.
      mov dx, offset comnam                          ;Name of device
      int dos
```

```
      jnc opnc01                          ;Carry clear means no error.
;deal with error
      mov ax, fromctrl                       ;Print out error message
      mov bx, offset openfail1
      call screen
      mov bx, offset comname
      call screen
      mov bx, offset openfail2
      call screen

      mov ax,0FFFFH                                  ;Flag bad port
      mov comport,ax
      jmp short opnc02                                       ;exit

opnc01:
      mov comport,ax                              ;Save file handle
      call uncook                        ;Set file to raw data mode
opnc02:
      ret                                                    ;Done
open_com endp
;
```

The DOS function 3DH, open handle, is used to 'open' the com port. It takes two operands, the name of the file and a byte which defines how the file will be used. If the open fails (comname may have been set to a non-valid device with the C command in ATERM) then DOS returns with carry set. Open_com tests this and generates an error message if the carry flag is set. If the file is successfully opened DOS returns a word handle which is stored in the variable comport. The handle is DOS' way of identifying the file when ATERM later accesses it. If the open fails a dummy value of -1 (0FFFFH) is used.

At this stage the device driver has not been accessed. The open handle function allows DOS to prepare for I/O to the port, setting up its variables and buffers.

MS-DOS will by default alter certain control characters as they are sent and received. We can alter the mode that DOS assigns to the file from the default (called 'cooked', where translations are performed) to a more direct one (called 'raw'). The raw mode has the advantage that data transfers are performed on as many bytes as possible at a time, rather than one byte at a time, as cooked mode does. The change from cooked to raw mode is performed by the subroutine uncook.

Figure 8-2. Subroutine Uncook.

```
;*********************************************************************
;*                                                                   *
;*  uncook-routine sets mode of file to raw data. I/O                *
;*          is performed as many bytes as possible at a time, and    *
;*          control characters are not trapped.                      *
;*                                                                   *
;*********************************************************************
;
; On entry
;   AX = valid file handle (note this routine does no checking)
;
; On exit
;   AX undefined
;   DX undefined
;   BX = file handle
;
;   Flags undefined
;   All other regs unaffected.
;   Stack useage-as DOS functions 44H
;
;
uncook proc near
      mov bx,ax
      mov ah,44H                                        ;DOS IOCTL
      mov al,0                                    ;Get device data
      int dos

      xor dh,dh
      or dl,00100000b                           ;Set bit 5 of data
      mov ah,44H                                        ;DOS IOCTL
      mov al,1                                    ;Set device data
      int dos

      ret
uncook endp
;
```

Uncook uses DOS service 044H to read alter, and set the device data that DOS maintains.

Reading From The File.

The subroutine inpstr below reads from the serial port.

Figure 8-3. Subroutine Inpstr.

```
;*********************************************************************
;*                                                                   *
;*  Inpstr- attempts to read a character from the serial             *
;*          port if echo to line is set then echo character back     *
;*          to port. Character is written to xiobuf.                 *
;*                                                                   *
;*********************************************************************
; On entry
;
;   Segment registers as start proc
;
; On exit
;
;   Carry = true ==> character has been read
;   Carry = false ==> no character read
;
;   AX undefined
;   BX undefined
;   CX undefined
;   DX undefined
;   xiobuf = character read
;
;   Other lags undefined
;   All other regs unaffected.
;   Stack useage-DOS service 3FH (and outstr if echoed)
;
inpstr proc near
      mov ah,3FH                                ;DOS read file handle
      mov bx,comport                                    ;File handle
      mov cx,1                                      ;Read 1 character
      mov dx,offset xiobuf                        ;Where to store it
      int dos

      cmp ax,1                                          ;Number read
      jne inst01                                          ;None read

      mov ax,echo                                        ;Check echo
      and ax,echol
      jz inst03                                             ;No echo
                                                               ;echo
      mov cx,1                                          ;1 character
      call outstr                                          ;send it
inst03:
      stc                                                ;Some read
      jmp short inst02

inst01:
      clc                                                ;None read
```

```
inst02:
      ret                                                    ;done
inpstr endp
;
```

The read is performed by DOS service 03FH, read handle, to read bytes into a buffer in ATERM's memory (xiobuf). It is at the first access of the port for a read or write that the driver itself is actually accessed. It sets up its internal buffers, which are essential for interrupt driven I/O, and initialises the serial hardware. Service 03FH returns the number of bytes read. Inpstr() also handles echo to line, by calling outstr(), the serial output function.

Writing To The File.

Writes to the serial port are performed by outstr, below.

Figure 8-4. Subroutine Outstr.

```
;*********************************************************************
;*                                                                   *
;*  Outstr- sends characters from xiobuf to serial port.             *
;*          Reports error to user if this fails. The routine         *
;*          returns anyway.                                          *
;*                                                                   *
;*********************************************************************
;
; On entry
;   CX = number bytes to send
;   Segment registers as start proc
;   xiobuf = characters to be sent
;
; On exit
;   AX undefined
;   BX undefined
;   CX undefined
;   DX undefined
;   xiobuf unaffected
;
;   Flags undefined
;   All other regs unaffected.
;   Stack useage- as DOS service 40H
;
outstr proc near
      mov ah,40H                                        ;DOS write handle
      mov bx, comport                                        ;File handle
      mov dx,offset xiobuf                                    ;Where data
      int dos
```

```
      jnc outs01                                        ;Data sent ok

      mov ax,fromctrl                             ;Flag source of output
      mov bx,offset writefail
      call screen                                 ;Display error message

outs01:
      ret
outstr endp
```

The DOS function 040H is used to write characters to the serial port. This returns carry set if there was some problem in sending data out. Such errors are tested by outstr, as above.

Closing The File.

The subroutine close_com is used to close the file, below.

Figure 8-5. Subroutine Close_com.

```
;*********************************************************************
;*                                                                   *
;*  Close_com-attempts to close file comport. Sets file              *
;*          handles to -1.                                           *
;*********************************************************************
;
; On entry
;   Segment registers as start proc
;   Other regs undefined
;   variable comport = handle associated with serial port
;
; On exit
;   AX undefined
;   BX undefined
;
;   Flags undefined
;   All other regs unaffected.
;   comport = -1
;   Stack useage-as DOS functions 3EH
;
close_com proc near
      mov bx,comport
      cmp bx,-1                                   ;-1 means not set
      je clsp01

      mov ah,3EH                                  ;DOS close handle
      int dos
      mov comport,-1                              ;Set unset status
```

```
clsp01:
      ret                                                    ;Done
close_com endp
```

DOS function 03EH does not access the device driver, but merely informs DOS that the program no longer wishes to use the file.

Serial Port Parameters.

The serial port settings, the Baud rate, parity etc., must be set to the values that the remote device requires. In ATERM this is all done by one subroutine, bios_x_init.

Figure 8-6. Subroutine Bios_x_init.

```
;*********************************************************************
;*                                                                   *
;*  bios_x_init-check the global parameters for baud rate etc.       *
;*          if they are ok then use to set the current serial port   *
;*          return carry set if fails.                               *
;*                                                                   *
;*********************************************************************
;
; On entry
;   Segment registers as start proc
;   Globals comno,baud,parity,stopbits,startbits set with values
;
; On exit
;
;   Carry = true ==> values bad, could not set port
;     AH,BX,CX,DX undefined
;   Carry = false ==> values good, used to set port.
;     AX,BX,CX,DX as BIOS service 04H
;   Other flags undefined
;   All other regs maintained.
;   Stack useage-as BIOS service (currently 22 bytes)
;
; Note- this service assumes the presence of Brain Boxes Asynchronous
;   BIOS. This is included in the Brain Boxes serial device driver.
;
bios_x_init proc near
      mov al,brk
      cmp al,1
      ja bxi01                                    ;Bad break parameter
      mov bh,parity
      cmp bh,4
      ja bxi01                                        ;Bad parity
      mov bl,stopbits
```

```
        cmp bl,1
        ja bxi01                                    ;Bad stop bits
        mov ch,databits
        cmp ch,3
        ja bxi01                                    ;Bad data bits
        mov cl,baud
        cmp cl,0BH
        ja bxi01                                    ;Bad baud rate
        mov dx,comno
        cmp dx,15
        ja bxi01                                        ;Bad port
        mov ah,04H                          ;BIOS extended initialise
        int com                            ;BIOS asynchronous services

        clc
        jmp short bxi02                                ;exit good

bxi01:
        stc                                             ;exit bad
bxi02:
        ret
bios_x_init endp                                            ;done
;
```

Bios_x_init uses the extended initialise service supplied as part of NewBIOS to set up the port. It works its way though the port parameters, checking that each has a valid value. The chapter "NewBIOS Reference" describes the parameters that service 4, the extended initialise, requires.

Bios_x_init returns a carry false to show that is has checked its parameters, found them to be ok, and used them to set the serial port. If the parameters are bad then carry is returned set and the serial port is left alone.

Fitting The Parts Together.

The main part of ATERM is shown in Figure 8-7.

Figure 8-7. Aterm Main Program.

```
;*********************************************************************
;*                                                                   *
;*  Aterm main program. Sets up terminal (possibly using an          *
;*          external file of commands). Alternately polls keyb'd     *
;*          and RS-232 port and sends out and displays               *
;*          respectively any characters received.                    *
;*                                                                   *
;*********************************************************************
;
start proc far
;
;Initialise segment registers.
      mov ax,data
      mov ds,ax                      ;Initialise data segment register
assume ds:data
      mov psp,es                  ;Save location of PSP-used elsewhere
      mov es,ax                     ;Initialise extra segment register
;
assume es:data, ss:stack, cs:code
;
      call exec_defaults                ;Use terminal definition file

      call open_com                                  ;Open serial port

mainloop:                                           ;Main program loop

      call sendout              ;Get characters/commands from keyboard

      call readin                             ;Get characters from port

      jmp short mainloop                             ;End of main loop

start endp
;
```

Exec_defaults checks for a command line parameter and attempts to execute the file of commands to which it refers. If it cannot find the file, or if no file is specified on the command line then the file 'TERMDEF.TXT' is tried. Open_com opens the serial port, as discussed in the previous section. The program then enters an infinite loop which alternately calls two subroutines, switchout and readin.

Readin checks for characters at the serial port, calling the function inxlat (that is input and translate), which in turn calls inpstr, discussed in the previous section, and xlt, to translate the

character received. If inxlat returns a non-empty string of characters then readin prints them out.

Switchout polls the keyboard using kbdwait. A character, if entered, is compared with zero. A zero byte indicates an extended character code, used for the function keys, cursor and edit keys and ALT key combinations. These are all taken to be commands, and so the function subroutine is called to deal with them. All other keys are echoed (if echo to screen has been set), and then passed on to outxlat. Outxlat translates the characters by calling xlt, and uses outstr to send them on to the serial port. Outstr is examined in the section above.

Menuout deals with the function keys and the ALT-C key. It reads the second byte of the extended key code and interprets it as a request to perform a certain action, and calls cmdout for help, quit and commands, and setup for the setup option. Cmdout decodes a character string as a command (whether the string is from the keyboard, a file or a literal in the program does not matter), calling one of the command execution routines to do the actual work. Setup present the user with a group of menus to set up the serial port. It gets options from the user and calls the command execution routines to perform them.

Note the use of the subroutines screen, screenewl and screenchar throughout for output to the screen. These subroutines at this time simply use DOS service 02H to send characters to the screen (stdout), but are used so that future versions of ATERM can easily use separate windows or a marking scheme to separate the three type of text that appear on the screen-characters from the serial port (’fromport’), echoed characters from the keyboard (’fromecho’), and control information from the program (’fromctrl’). A parameter of screen, screenewl etc flags this. Figure 8-8 gives several examples of this.

Figure 8-8. Screen Output.

```
;
      test echo,echos                                    ;Check echo
      jz snd03                                      ;No echo to screen
                                                       ;Echo to screen
      mov xiobuf,al                                  ;Store in buffer
      xor al,al
      mov xiobuff+1,al                                  ;nul terminate
      mov ax,fromecho
      mov bx,offset xiobuf
      call screen                                              ;Output
      mov al,xiobuf                                ;Get character back
snd03:
;
;
;
      mov al,xiobuff                                    ;Get character
      mov si,offset inxlt                                      ;input
      call xlt                                             ;translate

      mov al,0
      mov [di],al                                       ;nul terminate

      mov ax,fromport
      mov bx,offset xiobuf
      call screen                                   ;Display character
;
;
;
      badcmdmes db  'Cannot understand command:-',newl,'       ',0
      .
      .
      mov ax,fromctrl
      mov bx,offset badcmdmes                       ;Signal bad command
      call screen
;
```

It can be seen that from assembly language serial ports are comparatively easy to program, though the details of Aterm may obscure this.

Chapter 9

Pasterm

Introduction.

Pascal is a widely used and well structured language. Borland's implementation of it, Turbo Pascal, is popular and offers many extra features which make programming the serial ports that NewCOM provides very simple.

Pasterm is a Turbo Pascal v4 terminal emulation. Its main purpose is to demonstrate how serial ports can be programmed from Turbo Pascal, but it is in its own right a powerful tool for using serial devices.

This chapter contains two main sections. The first and most important section discusses the way that Pasterm uses the serial port. The second section takes a less detailed look at the organisation of the whole of Pasterm.

Running Pasterm.

Once the driver and port have been set up the user can execute Pasterm using the command

c>**Pasterm <definition_file>**

where <definition_file> is the optional name of a text file containing commands for Pasterm to read when it starts. These define the way that Pasterm will work, and are detailed in the chapter "Terminal Emulators".

Once the terminal is running any characters typed at the keyboard are sent to the serial port, and any characters received from the serial port are displayed on the screen. At any time the user can hit a function key, which have the following effects:

F1 Display a help screen

F2 Setup. This is a group of menus which interactively set up the serial port. At each menu the user must hit one of the digit keys to make a selection. The menus include setting the port, the Baud rate, the number of data bits, the number of stop

bits and the parity.

F10 Quit. This immediately exits the program.

ALT-C (That is 'C' and the 'ALT' key pressed together). Pasterm prompts the user for a command. The user can enter a command together with any parameters that it requires. These are the same commands found in the definition files, and control the way that the terminal functions.

The Pasterm Serial Connection.

This section will look at the parts of Pasterm that access the serial port and so explain how any Pascal program could use the serial port with NewCOM. The use of the serial port is quite straight forward, as NewCOM does most of the hard work.

Quick Summary.

Pasterm uses the following commands to perform serial input/output.

```
VAR
      com:     File Of Char;          { Create file variable }
.
Assign( com, 'COM1');         {                              }
Reset( com );                              { Open file input }
Rewrite( com );                           { Open file output }
.
Read( com, c );                        { Read from Serial port }
Write( com, c);                         { Write to serial port }
IF IoResult <> 0 THEN....                   { Check for errors }
.
Close( com );                             { Close serial port }
```

Pasterm uses the procedure Intr from the function BIOS_X_Init to access the BIOS services provided by NewCOM to set the Baud rate, parity etc. of the serial ports.

Pasterm also uses the procedure MsDos to access DOS function $44 codes 0 and 1 to get and set respectively the device information for a port. This allows the procedure Uncook to change the file associated with the serial port from cooked to raw data mode. This allows faster transfers of data and prevents DOS interfering with control characters.

Opening The File.

In Pasterm the Procedure 'Open_Com' opens the port.

Figure 9-1. Procedure Open_Com.

```
PROCEDURE Open_Com;                  {Open COM port for input, output}

PROCEDURE Uncook (VAR Filename: FileRec);  { Change the DOS mode of a
                                        text file from cooked to raw }
VAR
      ioregs :Registers;
BEGIN
      WITH ioregs, Filename DO BEGIN
      ax := $4400;                      { Function 44H, subservice 0H }
      bx := Handle;                                { get device data. }
      MsDos( ioregs );
      dh := 0;                           { Set high byte of data zero }
      dl := dl OR $20;                { Set bit 5 of low byte-raw mode}

      ax := $4401;                   { Subservice 1H, Set device data.}
      bx := Handle;
      MsDos( ioregs );
      END;
END;
VAR
      IO1,IO2     :Boolean;
BEGIN
      {$I-}
      Assign(Com_Inp,ComName);                    {Input Char file..}
      Reset(Com_inp);
      IO1 := IoResult <> 0;                            {Reset failed}

      Assign(Com_Out,ComName);                   {Output Char file..}
      ReWrite(Com_out);
      IO2 := IoResult <> 0;                          {ReWrite failed}
      {$I+}
      IF
            IO1 OR IO2
      THEN BEGIN                                  { Opens have failed }
            Screen('Failed to open '+ComName+Newl,FromCtrl);
            Screen('Try different port parameters'+Newl,Fromctrl);
            Close_Com;                                    {Close files}
      END
      ELSE BEGIN                                           { Opens ok }
            UnCook(FileRec(Com_Inp));              {Set RAW data mode}
            UnCook(FileRec(Com_Out));              {Set RAW data mode}
      END;
END;
```

This shows the two variables, type File Of Char, Com_Inp and Com_Out, that refer to the com port. They are the same file, but input and output refer to them via different files structures. A single file would have to be continually opened and closed with Reset and ReWrite as the file was read and written. Text files could be used, and have the advantage that strings and numbers can be read/written with ease. They do however impose certain restrictions on the file:- for example an end of file condition results in reads returning an eof character (ASCII character 26), so confusing 'no characters to read' with 'character 26 read'. The user may find that text files will suffice for their application. The Assign procedure initialises the file variable with certain internal parameters and the name of the file or device. The files are opened with the procedures Reset, for input, and ReWrite, for output. Before performing the open input/output error checking is switched off with the compiler directive {$I-}. If the Reset or ReWrite fails (ComName may have been set to a non-valid device with the C command in Pasterm) then the function IOResult returns a non-zero value. Open_Com tests this, and generates an error message and closes the files if the value after either Reset or ReWrite is non_zero. If error checking had not been disabled with {$I-} then a failure would halt the program with an error message. When the open is complete error checking is enabled with {$I+}.

At this stage the device driver has not been accessed. The Reset and ReWrite functions have simply allowed Turbo Pascal and DOS to prepare for I/O to the port, setting up their variables and buffers.

MS-DOS can process characters as they are sent and received. We can alter the mode that DOS assigns to the file from the default (called 'cooked', where this processing is performed) to a more direct one (called 'raw'). The raw mode has the second advantage that data transfers are performed on as many bytes as possible at a time, rather than one byte at a time, as cooked mode does. The change from cooked to raw mode is performed by the procedure UnCook, which is local to Open_Com. This uses DOS service $44 to read alter, and set the device data that DOS maintains. It accesses the record structure

that is the file variable to find the handle (a word) that DOS associates with the file.

Reading From The File.

The Procedure InpStr, Figure 9-3, reads from the serial port. The procedure is local to the function InXlat.

Figure 9-2. Procedure InpStr.

```
{Read a character from COM port.}
{If echo to line true then send it back out}
PROCEDURE InpStr (VAR s :Ins);
BEGIN
      {$I-}
      Read(Com_Inp, s[1]);                          { Read in Character}
      {$I+}
      IF
            IOResult = 0                                 { Any read in}
      THEN BEGIN
            s[0] := #1;                                { Set one read in}
            IF
                  Echol in Echo                           { Echo to line}
            THEN
                  OutStr(s);                              { Send to port}
            END
            ELSE BEGIN
                  s[0] := #0;                           { Set none read}
            END;
      END;
```

The read is performed by Read. It is at the first access of the port for a read or write that the driver itself is actually accessed. It sets up its internal buffers, which are essential for interrupt driven I/O, and initialises the serial hardware. If the driver can return no data then IOResult returns a non-zero value which InpStr checks. Inpstr also handles echo to line, by calling OutStr, the serial output procedure.

Writing To The File.

This is performed by OutStr, shown in Figure 9-3.

Figure 9-3. Procedure OutStr.

```
{Send a string to serial port}
{Must deal here with any errors}
PROCEDURE OutStr (s :String);
VAR
      i: Integer;
BEGIN
{$I-}
FOR i := 1 TO Length( s ) DO
      Write(Com_Out, s[i]);
      {$I+}
      IF
            IoResult <> 0                              { Write failure}
      THEN
      Screen('Failed to output characters to port.'+Newl,Fromctrl);
END;
```

The output procedure in Pascal used is Write. As before IOResult is used to trap errors that may have occurred.

Closing The File.

The procedure Close_Com, Figure 9-4, closes the file.

Figure 9-4. Procedure Close_Com.

```
{Close com files. Checks that they are open first}
PROCEDURE Close_Com;
BEGIN
      {$I-}                                    { Disable I/O checking}
      IF
            FileRec(Com_Inp).Mode = fmInput
      THEN
            Close(Com_Inp);
      IF
            FileRec(Com_Out).Mode = fmOutput
      THEN
            Close(Com_Out);
      {$I+}
END;
```

The Pascal procedure Close does not access the device driver, but merely informs DOS and Pascal that the program no longer wishes to use the file. Close_Com is performed just before the program ends, during a change of port on the 'C' command in Pasterm, or during Open_Com if the open fails.

Serial Port Parameters.

The serial port settings, the Baud rate, parity etc., must be set to the values that the remote device requires. The procedure in Pasterm which does this is BIOS_X_Init(), Figure 9-5.

Figure 9-5. Function BIOS_X_Init.

```
{Use BIOS services to set port parameters}
{Assumes presence of NewBIOS for extended initialise}
{Returns a flag to indicate whether it has succeeded}
FUNCTION BIOS_X_Init
         (Port: Integer; Brk, Par, Stop, Data, Baud: Byte) :Boolean;
VAR
      ioregs :Registers;
BEGIN
WITH ioregs DO BEGIN
      BIOS_X_Init := false;
      { Check port number}
      IF
            ( Port < 0  ) OR
            ( Port > 15 )
      THEN
      Exit;                                        { Bad Port number}
      DX := Port;
      { Check break setting}
      IF
            ( Brk < 0  ) OR
            ( Brk > 1 )
      THEN
            Exit;                                  { Bad Brk setting}
      AL := Brk;
      { Check parity}
      IF
            ( Par < 0  ) OR
            ( Par > 4 )
      THEN
            Exit;                                 { Bad parity number}
      BH := Par;
      { Check stop bits}
      IF
            ( Stop < 0  ) OR
            ( Stop > 1 )
      THEN
            Exit;                                  { Bad Stop number}
      BL := Stop;
      { Check word length}
      IF
            ( Data < 0  ) OR
```

```
        ( Data > 3 )
    THEN
        Exit;                                   { Bad Data number}
    CH := Data;
    { Check Baud rate}
    IF
        ( Baud < 0  ) OR
        ( Baud > 11 )
    THEN
        Exit;                                   { Bad Baud number}
    CL := Baud;

    AH := $4;                       { service 4, extended initialise}
                                                  { Do initialisation}
    Intr($14, ioregs);        {Int 14H is BIOS Asynchronous services
                                                              interrupt}
    BIOS_X_Init := true;  {This service does not generate any error
                                                                  codes}
    END;
END;
```

BIOX_X_Init uses the extended initialise service supplied as part of NewBIOS to set up the port. It first checks that the function parameters are valid. See chapter "NewBIOS Reference", service 4. The parameters are stored in the Registers variable ioregs, which is used to specify the parameters to Intr. The chapter "Using NewBIOS" explains the use of Intr in Turbo Pascal.

BIOS_X_Init returns a true flag to show that is has checked its parameters, found them to be ok, and used them to set the serial port. If the parameters are bad then a false flag is returned and the serial port is left alone.

Fitting The Parts Together.

The main block of Pasterm is shown in Figure 9-6.

Figure 9-6. Pasterm Main Program.

```
BEGIN
{  Variable initialisation section }
ComNo    := 0;
ComName  := 'COM1';
Baud     := 4;                                          { 1200 Baud}
Parity   := 2;                                             { Even}
DataBits := 2;                                  { 7 Bit word length}
StopBits := 0;                                        { 1 stop bit}
Brk      := 0;                                          { No break}

Echo := [];                                   { No echo in operation}

Init_Xlt(In_Xlt);
Init_Xlt(Out_Xlt);                    { Initialise translation tables}

Exec_Defaults;                { Find a definition file and execute it}

Open_com;                                        { Open Serial Ports}

WHILE true                                 { Main code is infinite loop}
DO BEGIN

      Readin;                           { Get any characters from port.}
                                       { Translate and send to display.}

      SwitchOut;          { Read and process characters from keyboard.}
      END;
END.
```

The first few lines and the procedure Init_Xlt set up internal variables for use by Pasterm. Exec_Defaults checks for a command line parameter and attempts to execute the file of commands to which it refers. If it cannot find the file, or if no file is specified on the command line then the file 'TERMDEF.TXT' is tried. Open_Com opens the serial port, as discussed in the previous section. The program then enters an infinite loop which alternately calls two procedures, SwitchOut and Readin.

Readin checks for characters at the serial port, calling the function InXlat (that is input and translate), which in turn calls InpStr, discussed in the previous section. If InXlat returns a non-empty string of characters then Readin prints them out.

SwitchOut polls the keyboard using Kbdinp. A character, if

entered, is compared with zero. A zero byte indicates an extended character code, used for the function keys, cursor and edit keys and ALT key combinations. These are all taken to be commands, and so the procedure MenuOut is called to deal with them. All other keys are echoed (if echo to screen has been set), and then passed on to OutXlat. OutXlat translates the characters and uses OutStr to send them on to the serial port. Outstr is examined in the section above.

MenuOut deals with the function keys and the ALT-C key. It reads the second byte of the extended key code and interprets it as a request to perform a certain action, calls CmdOut for help, quit and commands, and SetUp for the setup option. Cmdout decodes a character string as a command (whether the string is from the keyboard, a file or a literal in the program does not matter), calling one of the command execution routines to do the actual work. SetUp presents the user with a group of menus to set up the serial port. It gets options from the user and calls the command execution routines to perform them.

Note the use of the procedure Screen throughout for output to the screen. This function at this time simply calls Write and Writeln, but is used so that future versions of Pasterm can easily use separate windows or a marking scheme to separate the three type of text that appear on the screen- characters from the serial port (’Fromport’), echoed characters from the keyboard (’Fromecho’), and control information from the program (’Fromctrl’). The second parameter of Screen flags this. Figure 9-7 contains examples of this.

Figure 9-7. Screen Output Examples.

```
IF                                          { Process normal character}
     echos in echo                                { Echo to screen set}
THEN
     Screen(c, Fromecho);

Buffer := InXlat;                          { Read from port, translate}
IF
     Length( Buffer ) > 0
THEN
     Screen(Buffer, Fromport);                        { If any read echo}
```

```
Screen('Command not recognised'+newl,Fromctrl);
```

It can be seen that programming the serial ports that NewCOM provides is simple in Turbo Pascal, although the details of Pasterm may obscure this. The standard Pascal functions of Assign, Reset, ReWrite, Read, Write and Close allow the user to access the serial port. The port parameters such as Baud rate and parity can be set with the Intr procedure, which gives access to the BIOS asynchronous services.

Chapter 10

BASterm.

Introduction.

Large numbers of people turn to BASIC when they have a programming problem to solve because of its ease of use and the ability to get something working quickly. QuickBASIC and now Visual Basic for Dos are true professional programming languages. All of QBASIC, BASICA, GW-BASIC, QuickBASIC and Visual Basic for Dos allow the user to access the serial ports supplied by NewCOM, though for accessing the BIOS to set serial port parameters, BASICA/GW-BASIC programmers may have to do a little more work.

BASterm is a BASIC terminal emulator, designed to run under Microsoft QuickBASIC 4.5, Visual Basic for Dos and, with a minimal alteration to cover incompatible syntaxes, under GW-BASIC/BASICA.

This chapter contains two main sections. The first and most important section discusses the way that BASterm uses the serial port. The second section takes a less detailed look at the organisation of the whole of BASterm.

Running BASterm.

Once the driver and port have been set up the user can execute BASterm using the command

c>**BASterm <definition_file>**

where <definition_file> is the optional name of a text file containing commands for BASterm to read when it starts. These define the way that BASterm will work, and are detailed in the chapter "Terminal Emulators".

The user could also load the source code into the QuickBASIC environment and examine/execute it from there with the command

c>QB BASTERM /L

The switch '/L' is important because the program requires a subroutine, Interrupt, found in the library qb.qlb, loaded by the /L option.

From within the environment <definition_file> can be specified via Command$, which is set in the 'Run' menu (the user may first need to set 'full menus' in the 'Options' menu).

From within GW-BASIC or BASICA the user can load BASterm with the command

LOAD "BASTERM"

The program as distributed will run directly under QuickBASIC, but will fail under GW-BASIC/BASICA because of line 28470, the interface to the BIOS used by the latter BASICs. This line is commented out to allow QuickBASIC to compile the program, and must be reinstated before GW-BASIC/BASICA can run the program. The line should read:

```
28470 CALL ADDR(INREGS.AX, INREGS.BX, INREGS.CX, INREGS.DX): RETURN
```

Apart from this problem with mutually exclusive syntaxes the program will run correctly under either BASIC, detecting which BASIC it is running under and adjusting accordingly. The interface to the BIOS, which allows the program to change parameters associated with the serial port, such as Baud rate, is the only part of the program where the two BASICs diverge. The remainder of the program shys away from using the many extra features of QuickBASIC to maintain compatibility with GW-BASIC. The chapter "Using NewBIOS", discusses in detail the BIOS interface used with both QuickBASIC and GW-BASIC.

GW-BASIC does not recognise command line parameters for programs, so specify <definition_file> by setting COMMAND$ to the name of the file, eg.

COMMAND$ = "mydef.txt"

Run BASterm with the command:

RUN

Once the BASterm is running any characters typed at the keyboard are sent to the serial port, and any characters received from the serial port are displayed on the screen. At any time the

user can hit a function key, which have the following effects:

F1 Display a help screen

F2 Setup. This is a group of menus which interactively set up the serial port. At each menu the user must hit one of the digit keys to make a selection. The menus include setting the port, the Baud rate, the number of data bits, the number of stop bits and the parity.

F10 Quit. This immediately exits the program.

ALT-C

(That is 'C' and the 'ALT' key pressed together). BASterm prompts the user for a command. The user can enter a command together with any parameters that it requires. These are the same commands found in the definition files, and control the way that the terminal functions.

The BASterm Serial Connection.

This section will look at the parts of BASterm that access the serial port and explains how any BASIC program may use the serial port with NewCOM. The use of the serial port is quite straight forward, as NewCOM does most of the hard work. All PC BASICs include a special "OpenCOM" routine that bypasses normal file handling but is limited to only 2 ports. BASterm ignores this feature and instead uses NewCOM, so that multiple ports and different handshake schemes can be implemented.

Quick Summary.

The commands that BASIC uses to access the serial port are as follows. The BASICA and QuickBASIC versions use exactly the same file handling commands.

```
OPEN "R", #1, "COM1", 1              'Open port, for random i/o
FIELD #1, 1 AS P$                    'Set up P$ as i/o variable
.
GET #1                                'Read a character into P$
PUT #1                                'Send P$ to serial port.
IF EOF(1) THEN.....                     'Check for end of file
.
ON ERROR GOTO 10200                               'Trap errors
.
```

```
CLOSE #1                                    'Close the file
```

Because BASICA/GW-BASIC does not have an intrinsic method of accessing the BIOS, which contains the services supplied by NewCOM for setting the serial port parameters, and QuickBASIC does, the two programs use very different pieces of code to access the BIOS. QuickBASIC uses its 'CALL INTERRUPT' statement to access the BIOS. GW-BASIC /BASICA uses a small machine code routine to achieve the same effect. Both languages use the same subroutine at line 28000 to perform the access.

Opening The File

The following subroutine opens the serial port file.

Figure 10-1. Open Subroutine.

```
8000 '************************************************************
8010 'Open file to serial port
8020 :
8030 OPEN "R", #1, COMNAME$, 1     'Random file, record length=1 byte
8040 FIELD #1, 1 AS P$            'Define P$ as input/output variable
8050 :
8060 RETURN
8070 :
8080 :
```

Figure 10-1 shows the file number, 1, associated with the serial port. A random file was used to allow both writing and reading to and from the port. BASIC sequential files could be used in restricted applications-they only allow communication in one direction and are rather inflexible about input formats, but of course allow data to be formatted and type-converted easily, and have a simpler syntax.

At this stage the device driver has not been accessed. The OPEN statement has simply allowed BASIC and DOS to prepare for I/O to the port, setting up their variables and buffers.

Reading From The File.

The subroutine in Figure 10-2 reads from the serial port.

Figure 10-2. Input Subroutine.

```
9000 '************************************************************
9010 'Read characters from port, send to screen
9020 :
9030 ON ERROR GOT 9300
9040 :
9050 GET #1                                          'Attempt read
9060 :
9070 IF EOF(1) THEN RETURN                         'Eof ==> none read
9080 :
9090 ON ERROR GOTO 0
9100 :
9110 BUFFER$ = P$
9120 :
9130 'If echo to line then send to serial port
9140 IF ECHO AND ECHOL THEN GOSUB 10010
9150 :
9160 'Translate character
9170 BUFFER$ = INXLT$(ASC(BUFFER$))
9180 :
9190 'Output to screen
9200 FOR I = 1 TO LEN(BUFFER$)
9210  IF MID$(BUFFER$, I, 1) = CHR$(10) THEN PRINT : GOTO 9190
9220  PRINT MID$(BUFFER$, I, 1);
9230 NEXT I
9240 :
9250 RETURN
9260 :
9300 'Input error handler
9310 :
9320 RESUME 9340
9330 :
9340 ON ERROR GOTO 0
9350 :
9360 RETURN
9370 :
9380 :
```

The GET statement forces BASIC to access the driver, and the character returned is held in P$. At this first access of the port for a read or write that the NewCOM driver itself is actually accessed. NewCOM sets up its internal buffers, which are essential for interrupt driven I/O, and initialises the serial hardware. The EOF function is used to check whether the driver can return any data. The subroutine also handles echo to line (by calling the output subroutine), translates the character read and

outputs the translation to the screen. The ON ERROR statement allows the program to continue running even if an error occurs.

Writing To The File.

Writes to the serial port file are shown below.

Figure 10-3. Output Subroutine.

```
10000 '************************************************************
10010 'Send characters in buffer$ out to port.
10020 :
10030 ON ERROR GOTO 10200
10040 :
10050 FOR I = 1 TO LEN(BUFFER$)
10060   :
10070   LSET P$ = MID$(BUFFER$, I, 1)
10080   :
10090   PUT #1
10100   :
10110 NEXT I
10120 :
10130 ON ERROR GOTO 0
10140 :
10150 RETURN
10160 :
10200 'Output error handler
10210 :
10220 PRINT "Failed to output characters to port."
10230 :
10240 RESUME NEXT
10250 :
10260 :
```

The variable P$ is set to successive characters of the output string, and PUT is used to send these to the serial port. The ON ERROR trap catches any failure to write to the port.

Closing The File.

A simple CLOSE statement closes the file.

Figure 10-4. Closing The File.

```
15040 CLOSE #1
```

The BASIC CLOSE statement does not access the device driver, but merely informs DOS and BASIC that the program no longer wishes to use the file. CLOSE is performed just before the program ends and during a change of port on the 'C' command in BASterm.

Serial Port Parameters.

The serial port settings, the Baud rate, parity etc., must be set to the values that the remote device requires. In BASterm this is all done by one subroutine, at line 28000, Figure 10-5.

Figure 10-5. BIOS Access Subroutines.

```
28000 '*************************************************************
28010 'Set mode of com port-.
28020 'In QuickBASIC 4.5 uses 'call interrupt' to access BIOS
28030 'In GW-BASIC uses small machine code routine
28040 INITOK = 0
28050 'Check parameters are ok first
28060 IF COMNO < 0 OR COMNO > 15 THEN RETURN
28070 INREGS.DX = COMNO
28080 IF BRK < 0 OR BRK > 1 THEN RETURN
28090 INREGS.AX = &H400 OR BRK     '&H04 ==> service 4, extended init
28100 IF PARITY < 0 OR PARITY > 4 THEN RETURN
28110 IF STOPBITS < 0 OR STOPBITS > 1 THEN RETURN
28120 INREGS.BX = PARITY * 256 + STOPBITS
28130 IF DATABITS < 0 OR DATABITS > 3 THEN RETURN
28140 IF BAUD < 0 OR BAUD > 11 THEN RETURN
28150 INREGS.CX = DATABITS * 256 + BAUD
28160 :
28170 INITOK = -1                              'All parameters are ok
28180 IF ISBASICA THEN GOSUB 28410 ELSE GOSUB 28610
28190 :
28200 RETURN
28210 :
28220 :
28400 '*************************************************************
28410 'Call BIOS via machine code interface. GWBASIC
28420 :
28430 DEF SEG
28440 ADDR = VARPTR(ASM%(0))
28450 'Use the following here line in GWBASIC. It is commented out as
28460 'QuickBASIC refuses to compile it.
28470 'CALL ADDR(INREGS.AX, INREGS.BX, INREGS.CX, INREGS.DX): RETURN
28480 :
28490 PRINT "This is GW-BASIC, remember to uncomment line 28470"
```

```
28500 END
28510 :
28600 '************************************************************
28610 'Call BIOS via statement call interrupt. QuickBASIC 4.5
28620 :
28630 CALL INTERRUPT(&H14, INREGS, OUTREGS)
28640 :
28650 RETURN
28660 :
28670 :
```

The subroutine is Figure 10-5 uses the extended initialise service supplied as part of NewBIOS to set the port up. It works its way though the function parameters, checking that each has a valid value. The chapter "NewBIOS Reference", sets out the parameters that service 4, the extended initialise, requires. The parameters are stored in the variables inregs.ax etc., which are used to specify the parameters for the interrupt. QuickBASIC sees inregs as a single structured variable, and GW-BASIC sees inregs as four separate variables. The flag ISBASICA is set true earlier on (in the subroutine at line 27000, which sets up the BIOS interface) if the program detects that it is running under GW-BASIC/BASICA, and is tested to see whether a GW-BASIC-style BIOS call or QuickBASIC-style BIOS call should be made. These are separated into two subroutines, shown above, at lines 28400 and 28600 respectively. The chapter "Using NewBIOS", includes a full discussion of accessing the BIOS under QuickBASIC and GW-BASIC.

The variable initok returns true (-1) to show that the subroutine has checked its parameters, found them to be ok, and used them to set the serial port. If the parameters are bad then a false flag (0) is returned and the serial port is left alone.

Fitting The Parts Together.

The main program of BASterm is shown in Figure 10-6.

Figure 10-6. BASterm Main Program.

```
2000 DEFINT A-Z                                 'Use integers by default
2010 :
2020 'Definitions for QuickBASIC BIOS intface (GW-BASIC ignores this)
2030 ' $INCLUDE: 'QB.BI'
2040 :
2050 DIM ASM%(23)                            'BIOS interface for GW-BASIC
2060 :
2070 'Set main program variables.
2080 :
2090 BUFFER$ = ""                            'Hold text for input/output
2100 :
2110 DIM INXLT$(255), OUTXLT$(255)                        'Translations
2120 :
2130 COMNAME$ = "COM1"                             'Name of serial port
2140 COMNO = 0                                  '0..15 ==> COM1 to COM16
2150 BAUD = 4                                         'Baud rate number
2160 PARITY = 2                                     'Even parity number
2170 DATABITS = 2                                    '7 bit word length
2180 STOPBITS = 0                                           '1 stop bit
2190 BRK = 0                                                 'No break
2200 :
2220 PARITYS$ = " none  odd even markspace" 'Names of parity settings
2240 BAUD$ = "1200"                          'Name of current Baud rate
2260 DATS$ = "5678"                                  'Names of data bits
2280 STOPS$ = "12"                                   'Names of stop bits
2290 :
2300 'Setup menu data structures
2310 DIM OPTIONS$(9)
2320 :
2330 ECHO = 0                                                    'No echo
2340 ECHOS = 1                                 'Flag for echo to line
2350 ECHOL = 2                                'Flag for echo to screen
2360 :
2370 NEXTFILENUM = 2       'Next file for execute file routine to use
2380 :
3000 'Set up key definitions and traps
3010 :
3020 ON KEY(1) GOSUB 17000                                   'Help on F1
3030 KEY(1) ON
3040 :
3050 ON KEY(2) GOSUB 12000                                  'Setup on F2
3060 KEY(2) ON
3070 :
3080 ON KEY(10) GOSUB 15000                                 'Quit on F10
3090 KEY(10) ON
3100 :
3110 KEY 15, CHR$(&H8) + CHR$(&H2E)                              'ALT-C
3120 ON KEY(15) GOSUB 14010              'ALT-C is command processor
```

```
3130 KEY(15) ON
3140 :
3150 KEY OFF              'Turn off key displays at bottom of screen
3160 :
4000 GOSUB 27000                        'Initialise BIOS interface
4010 :
4020 GOSUB 6010                       'Initialise translation tables
4030 :
4040 GOSUB 8010                         'Open file to serial port
4050 :
4060  :
4070 GOSUB 7010                          'Execute definition file
4080 :
4090 :
5000 '************************************************************
5010 'Main program
5020 :
5030 WHILE 1                                          'Repeats forever
5040 :
5050   GOSUB 9010                     'Read in characters for port
5060 :
5070   GOSUB 9500           'Read characters/commands from keyboard
5080 :
5090 WEND                                            'End infinite loop
5100 :
5110 :
5120 END
5130 :
```

Lines 2000 to 2380 create the main variables used by the program. Most are initialised at this point. Lines 3000 to 3160 set up the key traps that the program uses. This rather unusual feature of PC BASIC allows a predefined subroutine to be executed when a particular key is hit. BASterm defines subroutines for function keys F1, F2 and F10, and ALT-C. This means that the normal program loop need not test for these keys. The subroutine calls to lines 27000 and 6010 complete the initialisation of program variables. 27000 is particularly interesting. It uses an error trap on a statement which is valid only in QuickBASIC to differentiate between QuickBASIC and GW-BASIC/BASICA, as different code is needed to manage the BIOS calls in each language. The serial port is opened at line 4040 (see Figure 10-1). Line 4060, a call to 7010, checks for a command line parameter and attempts to execute the file of commands to which it refers. If it cannot find the file, or if no

file is specified on the command line then the file 'TERMDEF.TXT' is tried. GW-BASIC does not have a command line access mechanism, so the variable which contains the command line in QuickBASIC, Command$, will be empty in GW-BASIC unless the user explicitly sets it before running the program.

The program then enters an infinite loop (lines 5000 to 5120) which alternately calls two subroutines, at lines 9010 and 9500. The subroutine at line 9010 is shown in Figure 10-2, above. The subroutine at line 9500 checks for characters at the keyboard and if any are read translates them and sends them to the keyboard via the subroutine at line 10000, shown in Figure 10-3.

The 'hot' keys F1, F2, F10 and ALT-C initiate routines as follows:

F1 Line 17000. Displays help information. Line 17000 is also called by the command decode routine for help information.

F2 Line 12000. Setup menus. These present the user with a series of menus to set parameters such as the Baud rate. These menu routines call on the various command execution routines.

F10 Line 15000. Quit program. Also called by command decode routine.

ALT-C Line 14010. Commands. The program prompts the user for a command, and passes this on to the command decode routine at 11000.

It can be seen that serial communications from BASIC are comparatively simple, though the complexities of BASterm and the difficulties of accessing the BIOS from BASICA/GW-BASIC may obscure this.

Chapter 11

Forterm

Introduction.

FORTRAN77 was the first high-level programming language, and now, much enhanced, is a mainstay of computing, especially in science and engineering applications. FORTRAN77 can easily be used to run the serial ports provided by NewCOM, and with the BIOS access function supplied with Serial Solutions the full range of serial software functions are available

Forterm is a Microsoft FORTRAN77 version 5 terminal emulator. It main purpose is to demonstrate the use of FORTRAN77 to program serial ports, but it is in its own right a useful tool for working with serial devices.

This chapter contains two main sections. The first and most important section discusses the way that FORterm uses the serial port. The second section takes a less detailed look at the organisation of the whole of Forterm.

Running Forterm.

Once the driver and port have been set up the user can execute Forterm using the command

c>**Forterm <definition_file>**

where <definition_file> is the optional name of a text file containing commands for Forterm to read when it starts. These define the way that Forterm will work, and are detailed in the chapter "Terminal Emulators".

Once the terminal is running any characters typed at the keyboard are sent to the serial port, and any characters received from the serial port are displayed on the screen. At any time the user can hit a function key, which have the following effects:

F1 Display a help screen

F2 Setup. This is a group of menus which interactively set up the serial port. At each menu the user must hit one of the

digit keys to make a selection. The menus include setting the port, the Baud rate, the number of data bits, the number of stop bits and the parity.

F10 Quit. This immediately exits the program.

ALT-C

(That is 'C' and the 'ALT' key pressed together). FORterm prompts the user for a command. The user can enter a command together with any parameters that it requires. These are the same commands found in the definition files, and control the way that the terminal functions.

The Forterm Serial Connection.

This section will look at the parts of Forterm that access the serial port and so explain how any Fortran program could use the serial port with NewCOM. The use of the serial port is quite straightforward, as NewCOM does most of the hard work.

Quick Summary.

The statements used by FORterm to access the serial port are as follows.

```
C Open serial port as unit 1, binary file, io is error check
      open (1, file='COM1', form='binary', iostat=io)
      .
C Read a character from the serial port
      read (i, iostat=io) c
      .
C Prepare file for output
      rewind( 1 )
      .
C Output characters to serial port. Line 1000 is an error trap
      write (1, err=1000) data(1:count)
```

The external subroutine intrpt, supplied as part of Serial Solutions, is used to access the machine BIOS service of NewCOM. These allow FORterm to set serial port parameters such as Baud rate and parity.

Opening The File.

The subroutine 'open_com', Figure 11-1, opens the unit associated with the serial port.

Figure 11-1. Procedure open_com.

```
C ********************************************************************
C *                                                                  *
C *  Open_com- opens com port                                        *
C *                                                                  *
C ********************************************************************
      subroutine open_com

C Port parameters definition common data
      integer*1 comno,baud,parity,databits,stopbits,brk
      common /port/ comno,baud,parity,databits,stopbits,brk
C Port name
      character*8 comname
      common /port/ comname

      integer io

C Binary sequential file.
      open (1, file=comname, form='binary',  iostat=io)

      if( io .NE. 0 )then
      call screen('Failed to open '//comname//'\n'C,2)
      call screen('Try different port parameters\n'C,2)
      else
      call screen('Opened serial port, called '//comname//'\n'C,2)
      end if

      end
```

Figure 11-1 shows the use of the open statement to attach a file to unit 1. The file is opened in binary mode, as opposed to formatted or unformatted, to minimise the extent to which FORTRAN alters the data being transferred. The 'iostat=io' field allows us to check for errors during the open. Open_Com tests the value of io, which indicates whether an error has occurred, and if so generates an error message.

At this stage the device driver has not been accessed. The open statement has simply allowed FORTRAN and DOS to prepare for I/O to the port, setting up their variables and buffers.

Reading From The File.

The function inpstr, Figure 11-3, reads from the serial port.

Figure 11-2. Function inpstr.

```
C ********************************************************************
C *                                                                  *
C *  InpStr reads a character from the serial port, and writes it    *
C *  to 'c'. The return value indicates whether any characters       *
C *  were read.                                                      *
C *                                                                  *
C ********************************************************************
      logical function inpstr (c)
      character c
      integer io

      read (1,iostat=io) c
      inpstr = ( io .EQ. 0 )
C Rewind file
C (which flushes internal buffer) only when no more characters
      if(.NOT. inpstr) rewind (1)
      end
```

The read is performed by the read statement. It is at the first access of the port for a read or write that the driver itself is actually accessed. It sets up its internal buffers, which are essential for interrupt driven I/O, and initialises the serial hardware. If the driver can return no data then io takes a non-zero value which inpstr checks. The rewind statement, which initialises the file for either reading or writing, is only called if no characters have been read from the port. This is to prevent rewind flushing the input buffer that FORTRAN maintains. Inpstr is called repeatedly until there are no more characters to read, and only then does the program cycle to writing to the serial port.

Writing To The File.

Writes are performed by the subroutine outstr.

Figure 11-3. Subroutine outstr.

```
C ********************************************************************
C *                                                                  *
C *  Outstr sends count characters to the serial port. Any write     *
C *  errors are dealt with.                                          *
C *                                                                  *
C ********************************************************************
```

```
      subroutine outstr (data, count)
      character *(*) data
      integer count

      rewind(1,err=1000)
      write (1,err=1000) data(1:count)
      rewind(1,err=1000)

      return

 1000 continue
      call screen('Failed to output characters to port.\n'C,2)
      end
```

The output statement in FORTRAN used is write. A different error check is used here. An i/o error causes control to be passed to line 1000, where an error message is printed. Note the use of rewind to prepare the file for use, and after the write operation to make sure that all data has actually been sent to the serial port.

Closing The File.

The FORTRAN statement close, Figure 11-4, is used to close the file.

Figure 11-4. Closing The File.

```
close(1)
```

Close does not access the device driver, but merely informs DOS and FORTRAN that the program no longer wishes to use the file. Close is performed just before the program ends and during a change of port on the 'C' command in Forterm.

Serial Port Parameters.

The serial port settings, the Baud rate, parity etc., must be set to the values that the remote device requires. In Forterm this is all done by one function, BIOS_X_init, shown in Figure 11-5.

Figure 11-5. Function BIOS_X_init.

```
C Interface to assembly language routine which calls interrupts
      interface to subroutine intrpt[FAR,ALIAS:"intrpt"]
      +            ( intno, regs)

      structure /regtype/
      union
        map
            integer*1 al,ah,bl,bh,cl,ch,dl,dh
        end map
        map
            integer*2 ax,bx,cx,dx,si,di,cflag
        end map
      end union
      end structure

      integer intno [far,reference]
      record /regtype/ regs [far,reference]
      end

C ********************************************************************
C *                                                                  *
C *  BIOS_x_init, checks its parameters, and if they fall within     *
C *  the correct ranges uses them to set the serial port via         *
C *  the BIOS services. Returns .TRUE. if works, else .FALSE.        *
C *                                                                  *
C ********************************************************************
      logical function BIOS_x_init(port, brk, par, stop, data, Baud)
      integer*1 port, brk, par, stop, data, Baud

      structure /regtype/
      union
        map
            integer*1 al,ah,bl,bh,cl,ch,dl,dh
        end map
        map
            integer*2 ax,bx,cx,dx,si,di,cflag
        end map
      end union
      end structure

      record /regtype/ registers

C Return false if any parameters bad
      BIOS_x_init = .FALSE.

      registers.ah = 4
      if( (port .LT. 0) .OR. (port .GT. 15) ) return
      registers.dx = port
```

```
      if( (brk .LT. 0) .OR. (brk .GT. 1) ) return
      registers.al = brk
      if( (par .LT. 0) .OR. (par .GT. 4) ) return
      registers.bh = par
      if( (data .LT. 0) .OR. (data .GT. 3) ) return
      registers.ch = data
      if( (stop .LT. 0) .OR. (stop .GT. 1) ) return
      registers.bl = stop
      if( (Baud .LT. 0) .OR. (Baud .GT. 11) ) return
      registers.cl = Baud

      call intrpt( 16#14, registers )

C Return true for good numbers
      BIOS_x_init = .TRUE.

      end
```

BIOS_X_Init uses the extended initialise service supplied as part of NewBIOS to set the port up. It works its way though the function parameters, checking that each has a valid value. The parameters are stored in the regtype structure registers, which is used to specify the parameters to intrpt. The chapter "Using NewBIOS", explains the use of intrpt in FORTRAN. The chapter "NewBIOS Reference", sets out the parameters that service 4, the extended initialise, requires.

BIOS_X_init returns a .TRUE. flag to show that is has checked its parameters, found them to be ok, and used them to set the serial port. If the parameters are bad then a .FALSE. flag is returned and the serial port is left alone.

Because intrpt is a separate module supplied with NewCOM and not part of FORTRAN, the interface statement is used to ensure that the correct parameters etc are passed to the subroutine.

Fitting The Parts Together.

The main block of Forterm is shown below.

Figure 11-6. Forterm Main Program.

```
      program FORterm

C Port parameters definition common data
      integer*1 comno,baud,parity,databits,stopbits,brk
      common /port/ comno,baud,parity,databits,stopbits,brk
C Port name
      character*8 comname
      common /port/ comname
C terminal data common
      logical echol,echos
      common /term/ echol,echos
C Internal variables common
      integer nextunit
      common /intvar/ nextunit

C Set up default values for translations
      call initxlt
C Set up other program variables
      echol = .FALSE.
      echos = .FALSE.
C Internal variable, used by exec_file
      nextunit = 7

C COM1, 1200 Baud, even parity, 7 data bits and one stop bit.
C Parameters are in form used by BIOS extended initialise.
      comname  = 'COM1    '
      comno    = 0
      baud     = 4
      parity   = 2
      databits = 2
      stopbits = 0
      brk      = 0

      call screen('\n'C,0)

      call exec_defaults

      call open_com

C Main program- is infinite loop
      do while (.TRUE.)

        call switchout

        call readin

      end do
```

```
end
```

The first few lines or the main program and the subroutine initxlt set up internal variables for use by Forterm. Exec_defaults checks for a command line parameter and attempts to execute the file of commands to which it refers. If it cannot find the file, or if no file is specified on the command line then the file 'TERMDEF.TXT' is tried. Open_com opens the serial port, as discussed in the previous section. The program then enters an infinite loop which alternately calls two subroutines, switchout and readin.

Readin checks for characters at the serial port, calling the function inxlat (that is input and translate), which in turn calls inpstr, discussed in the previous section. If inxlat returns a non-empty string of characters then readin prints them out.

Switchout polls the keyboard using Kbdinp. A character, if entered, is compared with zero. A zero byte indicates an extended character code, used for the function keys, cursor and edit keys and ALT key combinations. These are all taken to be commands, and so the procedure Menuout is called to deal with them. All other keys are echoed (if echo to screen has been set), and then passed on to outxlat. Outxlat translates the characters and uses Outstr to send them on to the serial port. Outstr is examined in the section above.

Menuout deals with the function keys and the ALT-C key. It reads the second byte of the extended key code and interprets it as a request to perform a certain action, calls cmdout for help, quit and commands, and Setup for the setup option. Cmdout decodes a character string as a command (whether the string is from the keyboard, a file or a literal in the program does not matter), calling one of the command execution routines to do the actual work. Setup presents the user with a group of menus to set up the serial port. It gets options from the user and calls the command execution routines to perform them.

Note the use of the subroutine screen throughout for output to the screen. This subroutine at this time simply calls write, but is used so that future versions of Forterm can easily use separate windows or a marking scheme to separate the three type of text

that appear on the screen- characters from the serial port (where the second parameter of screen is 0), echoed characters from the keyboard (second parameter 1), and control information from the program (second parameter 2). The second parameter of screen flags this. Figure 11-7 contains examples of this.

Figure 11-7. Screen Output Examples.

```
if( echos ) then
      c(2:2) = ''C
      call screen(c, 1)
end if

call inxlat( c )
if( c(1:1) .NE. char(0) )then
      call screen(c,0)
end if

call screen('Command not recognised\n'C,2)
```

It can be seen that from FORTRAN running the serial port that NewCOM provides is comparatively simple, and with the subroutine intrpt the full range of services provided by NewCOM are available.

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